Employing MPI sucessfully

An Overview

Joseph Kehoe[1]

[1]Department of Computing and Networking
Institute of Technology Carlow

CDD101, 2018

Introduction

Questions we need to answer when using MPI

- How can we balance the load equally across nodes
- When the process is distributed how do we ensure consistency
- How do we manage the communication overhead

Examples

We will look at two examples

- Wator Simulation (already implemented earlier)
- Game of Life, a well known and simple simulation

We will look at GoL, and then try apply to Wator

Institiúid Teicneolaíochta Cheatharlach
INSTITUTE of TECHNOLOGY CARLOW
At the Heart of South Leinster

Game of Life Rules

The universe of the Game of Life is an infinite two-dimensional orthogonal grid of square "cells", each of which is in one of two possible states, alive or dead. Every cell interacts with its eight neighbours. At each step in time, the following transitions occur:

- Any live cell with fewer than two live neighbours dies, as if caused by underpopulation.
- Any live cell with two or three live neighbours lives on to the next generation.
- Any live cell with more than three live neighbours dies, as if by overpopulation.
- Any dead cell with exactly three live neighbours becomes a live cell, as if by reproduction.

Game of Life Rules Continued

- The initial pattern constitutes the seed of the system.
- The first generation is created by applying the above rules simultaneously to every cell in the seed—births and deaths occur simultaneously, and the discrete moment at which this happens is sometimes called a tick (in other words, each generation is a pure function of the preceding one).
- The rules continue to be applied repeatedly to create further generations.

Load Balancing

- Divide system into equal packets of work
- Through data size or processing load (sometimes equal)

For the Game of Life:

- Each node can process a fraction of the grid
- Grid size might be a good predictor of work
- Grid can be split different ways (horizontally, vertically, etc.)

e.g. n nodes with each simulating $\frac{1}{n}^{th}$ of the grid

Institiúid Teicneolaíochta Cheatharlach
INSTITUTE of TECHNOLOGY CARLOW
At the Heart of South Leinster

Consistency

For the Game of Life:

- Each subgrid will need to communicate with its neighbouring subgrids between steps
- Cells on edge of grid need to know value of cells adjacent to them but hosted on different node

Can this be minimised?

Communication Overhead

For the Game of Life:

- Edge cells need to be sent to neighbouring nodes
- How could this be minimised
- (does the way arrays are stored affect anything?)
- Need to work out overhead versus grid size. For grids below a certain size the commmunication overhead will outweight the grid processing!

Can this be minimised?

Institiúid Teicneolaíochta Cheatharlach
INSTITUTE of TECHNOLOGY CARLOW
At the Heart of South Leinster

Efficiency

Once it is working start thinking about efficiency:

- Grid size to optimise communication overhead-processing time
- Grid shape to minimise communication
- Can we allow a grid to step ahead in time?
- does equal grid size mean equal work?

Institiúid Teicneolaíochta Cheatharlach
INSTITUTE of TECHNOLOGY CARLOW
At the Heart of South Leinster