HPC4M - Assignment 1 Report

Aidan Tully

February 1, 2021

Exercise 2 - Parallel Matrix Multiplication

For this task I created a script to parallelise matrix multiplication of two $N \times N$ matrices, A and B, given by

$$\begin{aligned} A_{i,j} =& (N - j + i + 1)i \\ B_{i,j} =& (j + i)(N - j + 1) \end{aligned}$$

where i and j are the row and column of each element in the matrices.

Solution

To achieve this, I started by implementing it with size $N = 3$ to test. Now with a revision, altering the N defined at the start of the script, it runs for any size N.

A root process is initially designated (here process 0 is chosen). This process creates the matrix B and broadcasts it as a 1D-array (see issues section below) using MPI_Broadcast(). Following this all processes individually compute the row of A they are assigned and then compute the row of the product $A_i \times B$ corresponding to their row A_i.

Next, the processes all send the computed rows back to the root process through the MPI_Gather() command and the root process then combines it with its own row to create the output matrix. This is subsequently printed.

Checking the matrix for $N = 3$ and for $N = 4$ achieved the correct result (both the slurm submission file and the .cpp file must be altered). Expanidng on this to ask the user for the input N would be interesting but not compatible with cirrus submission system as far as I am aware. The general case where the number of processes is not equal to N proved to be trickier to implement and is not included.

Issues encountered

The main issue I had was with trying to broadcast a 2D-array using MPI_Broadcast(). I couldn't work out how to do this so instead opted to broadcast B as a flattened matrix in 1-D. This made some of the loops slightly more annoying to deal with regard to the indexing, but seems to work well overall. Other than this everything went smoothly in my opinion.