COMP 4007: Parallel Processing and Computer Architecture

Programming Assignment 3

Due date: **22 December 2023 23:59**

Notes

1. All submitted code will be compiled and tested on the lab machines to evaluate the assignments.
2. Points may be deducted if your programs consistently achieve no speedup over the serial program.
3. Please zip all your code and reports into one file, named "ID_Name_Lab3.zip" (node that ID and name are your student ID and Chinese name respectively), and send it to the TA's email (hucheng.lew@qq.com).

Problem 1: Parallel Matrix-Matrix Multiplication using MPI

Please use MPI to parallelize matrix-matrix multiplication. Your program should:
(1) Request the user to input the sizes of the two matrices, say m, k, and n; which means the first matrix has the dimension of m * k, and the second matrix k * n;
(2) Create and initialize the matrices with random floating-point numbers;
(3) Perform serial matrix-matrix multiplication on a single CPU and measure its running time;
(4) Perform matrix-matrix multiplication with MPI and measure its running time;
(5) Compare the serial CPU results with MPI results;
(6) Output the size of the matrix, CPU running time, and MPI running time.

Problem 2: Write a ring-based Allreduce collective using MPI

Please use MPI to write a ring-based Allreduce collective (named RING_Allreduce) with **point-to-point communications**, and it should provide the same function as MPI_Allreduce. Only SUM and MAX operations need to be supported. Your program should do the followings:
(1) Request the user to input the size of the array, say n;
(2) Request the user to input the operation of Allreduce, sum or max;
(3) Create and initialize the array with random floating-point numbers;
(4) Perform MPI_Allreduce and measure its running time;
(5) Perform RING_Allreduce and measure its running time;
(6) Verify the results of your RING_Allreduce by comparing with the MPI_Allreduce version.
(7) Output the size of the array and running times of MPI_Allreduce and RING_Allreduce.