WITS UNIVERSITY

School of Computer Science and Applied Mathematics
UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

COMS3008A: Parallel Computing
Exercises 9

2021-10-21

1 Objectives

- Apply MPI point-to-point and collective communication functions to write MPI programs.
- Apply MPI derived datatypes in MPI programs.

2 Problems

For the solutions of the following problems, you are expected to use MPI derived datatypes wherever possible.

1. Write an MPI program that sends the upper triangular portion of a square matrix stored on process 0 to process 1.
2. Write a dense matrix transpose function: Suppose a dense $n \times n$ matrix $\mathbf{A}$ is stored on process 0. Create a derived datatype representing a single column of $\mathbf{A}$. Send each column of A to process 1, but have process 1 receive each column into a row. When the function returns, $\mathbf{A}$ should be stored on process 0 and $\mathbf{A}^{\mathrm{T}}$ on process 1.
3. Suppose we have p number of MPI processes, each holds a $k \times n$ matrix A_{sub}, and a vector x_{sub} of k dimensions (or components), where $kp = n$. If we put together all A_{sub} matrices from each process in the order of process ranks, we can obtain the full matrix A. Similarly, if we put together all x_{sub} vectors together, we can obtain the full vector x. Using such a distributed setting of a matrix and a vector among processes, write an MPI program that computes $\mathrm{B} = \mathrm{Ax}$, where each process holds only k rows of B that corresponds to the k rows of A.
4. Continued from problem 3, given the same distributed setting of A and x among the p processes, how would you compute $\mathrm{B} = \mathrm{A}^{\mathrm{T}}\mathrm{x}$ in a communication efficient manner? Implement your method.

5. Write an MPI program that completes Example 6 in Lec9 slides, where each process sends a particle to all the other processes using the derived datatype given in this example.