CS121 Problem Set 2

Instructions: This problem set is due by 11:59pm on April 6, 2020. Please submit your solutions on GradeScope, using course code MN4N88.

1) a) Suppose we have a problem for which there is a sequential algorithm running in time n on an input of size n. Now, consider a parallel algorithm for the problem which has parallel running time $n/p + 2 \log p$ when using p processors. Is it possible to maintain isoefficiency for this parallel algorithm? If so, give the necessary relationship between n and p.

   b) Suppose now the sequential running time is n^2 and the parallel running time is $n^2/p + n^3/\sqrt{p}$. Can this algorithm algorithm maintain isoefficiency, and if so, what is the necessary relationship between n and p?

2) Simulate the following MPI collective communications operations by writing code that uses only MPI point-to-point routines:

   a) `MPI_Bcast(buf, count, datatype, root, comm)`

   b) `MPI_Reduce(sendbuf, recvbuf, count, datatype, op, root, comm)`

3) Given a balanced binary tree, describe a procedure to perform all-to-all broadcast that takes time $(t_s + t_w\, m\, p\, /\, 2) \log p$ for m-word messages on p nodes. Assume that only the leaves of the tree contain nodes, and that an exchange of two m-word messages between any two nodes connected by bidirectional channels takes time $t_s + t_w\, m\, k$ if the communication channel (or a part of it) is shared by k simultaneous messages.

4) For the same situation as in problem 3, give another algorithm all-to-all broadcast that takes time $(t_s + t_w\, m)\, (p\text{-}1)$.

   Hint: Try to embed a p process ring in the tree.