CS121 Problem Set 2

Due: 23:59, April 6, 2021

1. Submit your solutions to Gradescope (www.gradescope.com).
2. In "Account Settings" in Gradescope, set FULL NAME to your Chinese name and enter your STUDENT ID.
3. If you submit handwritten solutions, write neatly and submit a clear scan.
4. When submitting your homework, be sure to match each of your solutions to the corresponding problem number.

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.