

CS 133 Parallel and Distributed Computing
Winter 2020
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Homework #3
Due 10pm, Feb. 13, 2020

Reading assignment:

Lecture notes 6, 7, 8, and 9.

Homework problems:

1. Why do we need the concept of “communicator” in MPI? What is the default communicator? Assuming that we have 16 processors involved in the parallel computation, please provide the MPI code to create 4 communicators such that all processors with identical $rank \bmod 4$ are in the same communicator, where $rank$ is the processor ID in the default communicator.
2. Given a list L of $k*N$ integers of value between 1 to m as the input evenly distributed among k processors stored in their local file systems, please write an efficient MPI program to generate the histogram h of list L at processor 0. Please make your function as efficient as possible, and highlight the MPI functions that you are using.
3. For the E-cube algorithm for all-to-all personalized communication discussed in Lectures 7 and 8, if we implement it on a 4-dimension hypercube, how many steps will the algorithm goes through? At Step 7, which processor will processor 5 exchange messages?
4. Consider the basic matrix multiplication algorithm for two $N \times N$ matrices A and B using $K \times K$ processors connected using a mesh network. Assume that each processor already has data the corresponding $N/K \times N/K$ sub-matrices of A and B , and only need to generate and store the resulting $N/K \times N/K$ sub-matrix locally. Please derive the isoefficiency relation and the scalability function. You may assume that N is a multiple of K .
5. In Lecture 9, we discussed the example shown on the right, which has a loop pipelining initiation interval equal to 2. If we only want to output $d[SIZE]$, can you rewrite the code so that the II becomes 1?

```
i = 1;
for (i=1; i<=SIZE; i++) {
    d[i] = d[i-1]*v[i];
}
```

Late submission policy:

We allow 12 hours delay with 10% penalty. After that, no submission will be accepted and the solutions may be discussed in the discussion sessions.