Fall 2025
Exam II (scaled to 30 points)
Thursday, November 6

DO NOT OPEN THIS EXAM UNTIL YOU ARE INSTRUCTED TO DO SO

Name:_____. Student ID No._____

1. **NO TALKING FROM THE TIME YOU ENTER THE EXAM ROOM UNTIL YOU HAVE EXITED THE EXAM ROOM!** Any violation will earn you an F on the exam, at a minimum.
2. If you have a question, come to the front of the room and whisper very quietly to the professor.
3. Please note any concerns of interpretation of a question on your exam.
4. **Write the exam with a dark colored pen or pencil.** Light colored pens or pencils do not scan well.

- **Plagiarism** will earn you an F in the course and a recommendation of expulsion from the university.
    - **a.** You may not refer to any material outside of this exam.
    - **b.** That is, you may **not** refer to notes, books, papers, calculators, phones, watches, other electronic devices, classmates, classmates' exams, and so forth.
    - **c. Do not talk to fellow students at any time while in the exam room.**
- Answer all questions on these pages. No code or pseudo-code is necessary – just a precise and concise explanation and justification.
- *Unsupported work will receive no credit.*

Q1 **Mesh** (8 pts) Given a mesh with n pieces of data evenly distributed amongst the processors, give an asymptotically cost-optimal solution with asymptotically optimal running time to compute the sum of the n values. Justify your answer.

Q2 **Tree** (7 pts total) Given a tree with n leaf processors, the following three questions require you to **give a lower bound** on the time to solve a problem. These questions do **not** ask for you to provide an algorithm to solve a problem and you will **not receive any credit for providing an algorithm/solution** to any of the following three problems.

a. (2 pts) Give a lower bound on the time to compute a global sum of n values, initially stored one value per leaf processor. Quality of your lower bound counts. Justify your answer.
b. (3 pts) Give a lower bound on the time to sort n pieces of data, initially stored one piece of data per leaf processor. Quality of your lower bound counts. Justify your answer.
c. (2 pts) Give a lower bound on the time to compute the parallel prefix of n values, initially stored one value per leaf processor. Quality of your lower bound counts. Justify your answer.

Q3 **Mesh-of-Trees** (7 pts) Given a Mesh-of-Trees of base size n, where every base processor initially contains a value that is either a 1 or a 0, determine the total number of base processors that contain a 1, for which at least 2 of its neighboring base processors also contain a 1. Your algorithm should have an asymptotically optimal running time. Quality of solution (*i.e.,* running time) counts. Justify your answer.

Q4 **Hypercube** (8 pts) Given a hypercube of size n with one piece of data stored per processor, give an algorithm with asymptotically optimal running time to determine the sum of the n pieces of data. At the end of the algorithm, all processors should know the global sum. Justify your answer.

Extra Credit (1 pt) Circle an area that Dr Miller works in.

1. Artificial Intelligence
2. Data Analytics
3. Computational Crystallography
4. Fluid Flow Optimization

Extra Credit (1 pt) What sport does Dr Miller currently play?

1. Baseball
2. Basketball
3. Soccer
4. Golf