CSCI-UA.0480-051: Parallel Computing
Practice Exam (Oct 26th, 2023)
Total: 100 points

Important Notes- READ BEFORE SOLVING THE EXAM

- If you perceive any ambiguity in any of the questions, state your assumptions clearly and solve the problem based on your assumptions. We will grade both your solutions and your assumptions.
- This exam is take-home.
- You have up to 24 hours to complete this exam.
- Your answers must be very focused. You may be penalized for giving wrong answers and for putting irrelevant information in your answers.
- Your answer sheet must be organized neatly.
- Your answers can be typed or written by hand (but with clear handwriting). It is up to you. But you must upload one pdf file containing all your answers.

Honor code (copy and paste to the first page of your exam)

"I understand the ground rules and agree to abide by them. I will not share answers or assist another student during this exam, nor will I seek assistance from another student or attempt to view their answers."

Problem 1

a. [10] What is the difference between shared memory and distributed memory parallel computing architectures? Explain with examples.

b. [10] Briefly explain Amdahl's Law and its implications for parallel program performance. How does it relate to the concept of parallelizable vs. non-parallelizable portions of a program?

Problem 2

a. [15] Describe the concept of a race condition in parallel programming. Provide a simple code example (in any language) illustrating a race condition and explain how it could be resolved.

b. [15] Explain the concept of a deadlock. Give an example scenario in parallel programming where a deadlock could occur. Suggest strategies for preventing deadlocks.

Problem 3

a. [15] Compare and contrast the performance characteristics of different parallel programming models (e.g., MPI, OpenMP). Discuss their strengths and weaknesses in terms of scalability, ease of use, and portability.

b. [15] Explain how load balancing is crucial for efficient parallel computation. Discuss some common techniques used to achieve load balancing in parallel programs.

Problem 4

[20] Consider the following parallel algorithm for matrix multiplication:

```
for i = 0 to n-1 do
    for j = 0 to n-1 do
        C[i,j] = 0;
        for k = 0 to n-1 do
            C[i,j] = C[i,j] + A[i,k] * B[k,j];
```

a) Analyze the algorithm's inherent parallelism. How can it be parallelized?

b) Identify any potential bottlenecks in the algorithm and suggest strategies for mitigating them.

Problem 5

[20] You are tasked with designing a parallel program to process a large dataset of images. Each image requires independent processing.

a) Describe a suitable parallel programming model for this task. Justify your choice.

b) Explain how you would partition the workload among the available processors to maximize efficiency. What factors would influence your partitioning strategy?