Parallel Computing

Practice Exam

Difficulty: medium

CSCI-UA.0480-051: Parallel Computing

Practice Midterm Exam (October 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 from the time you start to submit your solutions.
* You are allowed only one submission.
* Your answers must be very focused. You may be penalized for wrong answers and for putting irrelevant information in your answers.
* You must upload a PDF file.
* Your answer sheet must have a cover page (as indicated below) and one problem answer per page (e.g., problem 1 in a separate page, problem 2 in another separate page, etc.).

The very first page of your answer is the cover page and must contain:

Your Last Name
Your First Name
Your NetID
Copy and paste the honor code shown in the rectangle at the bottom of this page.

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 (30 points)

a. [10] Explain Amdahl's Law and its implications for parallel programming. Give a practical example.

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b. [10] What are the key differences between shared memory and distributed memory parallel computing systems? Provide examples of each.

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c. [10] Briefly describe three common parallel programming paradigms. Give an example of a problem well-suited for each.

Problem 2 (35 points)

Consider a parallel algorithm for matrix multiplication of two 4x4 matrices A and B, resulting in matrix C. Assume you have 4 processing cores.

a. [15] Describe a strategy for dividing the work among the four cores to achieve parallelism. Illustrate with a diagram.

b. [10] Discuss the potential sources of overhead in your proposed parallel algorithm. How could you mitigate these overheads?

c. [10] If each multiplication operation takes 1 unit of time, and communication between cores takes 2 units of time, estimate the total execution time of your algorithm. Show your calculations.

Problem 3 (35 points)

a. [15] Explain the concept of a race condition in parallel programming. Provide a simple code example (in pseudocode or any language you prefer) demonstrating a race condition, and show how you would fix it using appropriate synchronization mechanisms.

b. [20] Describe deadlock in the context of parallel programming. Give an example scenario where deadlock might occur, and discuss strategies to prevent or avoid it.