

CSCI-UA.0480-051: Parallel Computing

Practice Exam

Generated on October 26, 2023

Difficulty: Medium

Important Notes:

- Answer all questions to the best of your ability
- Show all work for partial credit
- Use additional paper if needed
- Time limit: 90 minutes

Problem 1 (12 points)

Explain the concept of Amdahl's Law and how it limits the speedup achievable through parallelization. Provide a specific example to illustrate its implications for a program with a portion that cannot be parallelized.

Problem 2 (8 points)

Describe the differences between shared memory and distributed memory parallel computing architectures, including their advantages and disadvantages in terms of programming complexity, communication overhead, and scalability.

Problem 3 (8 points)

Compare and contrast two different parallel programming models (e.g., MPI and OpenMP), highlighting their strengths and weaknesses when applied to solving a computationally intensive problem like matrix multiplication.

Problem 4 (10 points)

What are race conditions and deadlocks in parallel computing, and how can they be prevented or mitigated using synchronization primitives like mutexes, semaphores, or barriers? Provide examples.

Problem 5 (8 points)

Explain the concept of load balancing in parallel computing and discuss various strategies for achieving optimal load distribution among processors in a parallel application. Consider both static and dynamic load balancing approaches.

Problem 6 (12 points)

How does the choice of a parallel algorithm influence the performance and scalability of a parallel program? Illustrate with an example comparing a parallel algorithm that exhibits good scalability with one that does not.

Problem 7 (12 points)

Describe the challenges associated with debugging and profiling parallel programs. What tools or techniques can be used to identify and address performance bottlenecks or concurrency bugs in parallel applications?

Problem 8 (8 points)

Explain the role of inter-process communication (IPC) in distributed memory parallel computing. Discuss various methods of IPC and their relative performance characteristics, considering factors like latency and bandwidth.

Problem 9 (5 points)

Discuss the trade-offs between using threads and processes for parallelization. Under what circumstances would you choose one approach over the other? Justify your answer with examples.

Problem 10 (17 points)

How does data locality affect the performance of parallel programs? Explain the concept of cache coherence and its importance in shared-memory parallel systems. Discuss strategies for improving data locality.