

# Parallel Computing Practice Exam

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Difficulty: Medium

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1. Describe the difference between shared memory and distributed memory parallel computing architectures. Provide a specific example of a problem that would be better suited to each architecture and explain why, considering factors such as communication overhead and data locality.
2. You are tasked with implementing a parallel algorithm to perform matrix multiplication of two large matrices (1000x1000 each) on a system with 8 processors. Outline a suitable parallel strategy, detailing how you would partition the matrices and manage communication between processors to minimize runtime. Discuss potential bottlenecks and how you might mitigate them.
3. Explain the concept of Amdahl's Law and its implications for parallel program design. Suppose you have a program where 70% of the code is parallelizable. If you have access to a system with 16 processors, what is the theoretical maximum speedup you can achieve? Show your calculations and discuss the limitations of Amdahl's Law.
4. Consider the task of sorting a large array of integers using a parallel merge sort algorithm. Describe how the divide-and-conquer strategy would be applied in a parallel environment. Specifically, detail the steps involved in the parallel merging phase and discuss potential challenges related to load balancing and efficient inter-processor communication.
5. Compare and contrast two different parallel programming models: OpenMP and MPI. Discuss their strengths and weaknesses, considering factors such as ease of programming, scalability, and suitability for different types of parallel architectures (shared memory vs. distributed memory). Provide examples of situations where one model would be preferable over the other.