Parallel Computing Practice Exam

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Difficulty: Medium

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1. Consider a parallel program designed to compute the Mandelbrot set using a grid of pixels. Describe two different approaches to distributing the workload across multiple processors, highlighting the advantages and disadvantages of each approach in terms of load balancing, communication overhead, and scalability. Specifically address how the choice of data partitioning strategy (e.g., row-wise, column-wise, or a more sophisticated method) impacts performance.

2. A parallel program uses a master-worker architecture to process a large dataset. The master distributes tasks to worker processes, and the workers return their results to the master. Assume that the dataset consists of 1000 independent tasks, each taking an average of 10 milliseconds to process. The overhead of distributing a task is 1 millisecond, and the overhead of collecting the result is 1 millisecond. If you have 4 worker processes, estimate the total execution time. Justify your calculations and explain how the execution time would change if you increased the number of worker processes to 8, considering both the benefits and potential limitations of adding more workers.

3. Explain the concept of Amdahl's Law in the context of parallel computing. Illustrate its application with a specific example: Consider a program where 80% of its execution time is inherently sequential and cannot be parallelized. Calculate the theoretical speedup achievable if you use 10 processors, and discuss the limitations of expecting a linear speedup in this scenario. What factors other than the parallelizable fraction might limit the actual speedup obtained in a real-world implementation?