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Set 3 - OPENMP and GPUs

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Question 1: OpenMP and Complex Matrix Multiplication

2D complex matrix multiplication involves the multiplication of two matrices where the elements are complex numbers. The standard rules of matrix multiplication apply, in addition to handling complex number arithmetic.

To compute the product of two NxN matrices of the form $(A + Bi)$ and $(C + Di)$, where A, B, C, and D are real NxN matrices, we use the rules of complex number multiplication and matrix operations. The computation follows the following formula:

$$(A + Bi)(C + Di) = (AC - BD) + (AD + BC)i = E + Fi \tag{1}$$

where E and F are the real and imaginary parts of the result.

a) Develop an OpenMP-based GPU application that implements the above-described complex matrix multiplication. The four matrices, A, B, C, and D, are allocated and initialized with random values on the host. The results will be stored in the two matrices, E and F.

b) In your report, describe the main design and optimization decisions you applied to your implementation.

c) Measure and report the performance of your implementation for different values of N. Optionally, compare the performance of your OpenMP implementation with an equivalent sequential CPU-based implementation.

Make sure that all your implementations give correct results.