ID5130 Parallel Scientific Computing

Assignment 3

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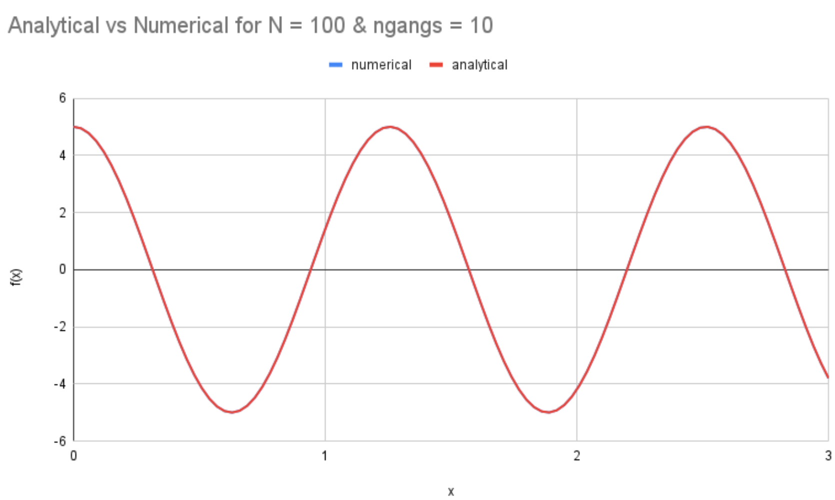
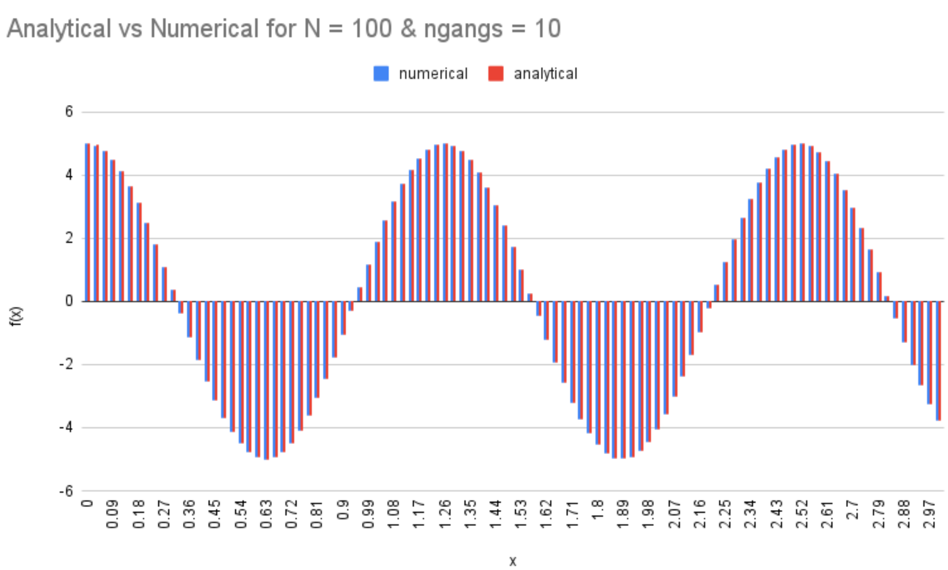
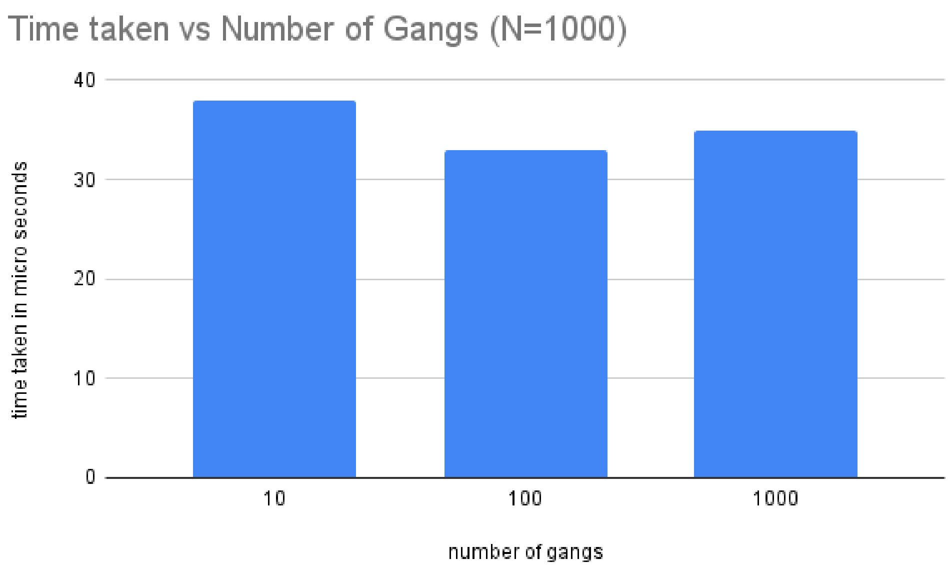
1 Programming Question 1

The task is to parallelize LU decomposition for the tridiagonal matrix. As there is very little scope for parallelism, I have extended the problem statement to any general matrix A, essentially Gaussian elimination implementation. Below are the relevant plots.





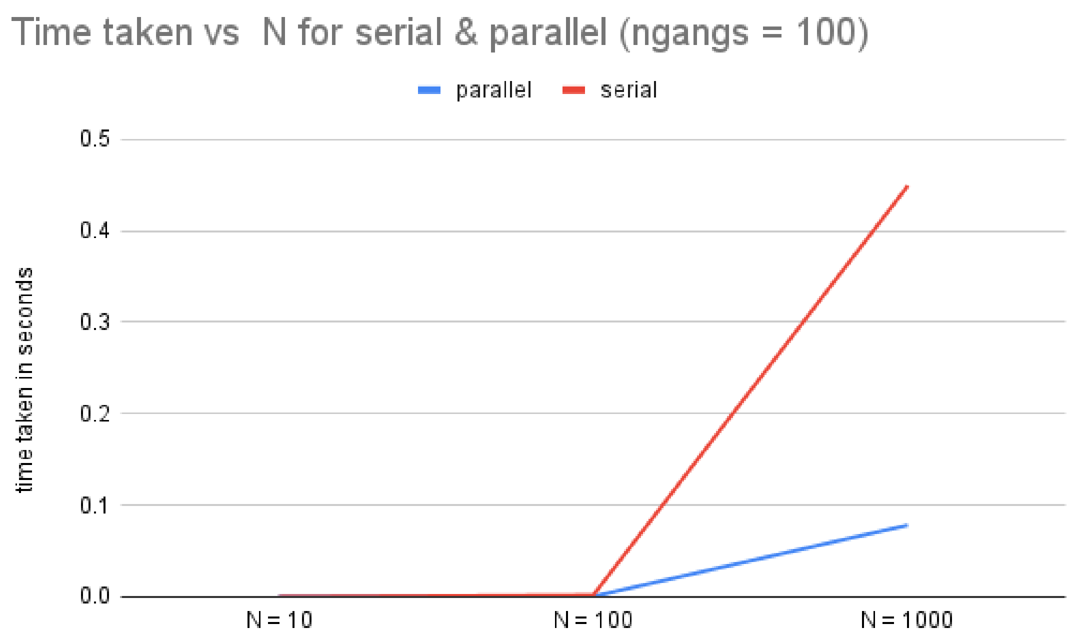
The time taken for the parallel code to be executed for different gangs values are as follows.



Number of gangs = 100 takes the least execution time, followed by 1000 and 10. However, it can be noted that the execution time is almost similar. This is because the algorithm is being applied on a tridiagonal matrix, which is highly sparse. Hence, the benefits of parallelism are not observable. For a dense matrix, the advantage gained will be more predominant.

2 Programming Question 2

A major scope of parallelism, even in this problem set, was observed in the initialization step. The Cholesky algorithm has loop-carried dependencies to a great extent, due to which there isn't a lot of flexibility in parallelizing the code. The results of Cholesky algorithm implementation on OpenACC are as follows:



The advantage of parallelizing can be seen as the problem size increases. The speed-up obtained for N=1000 is almost 5 times.

Below are the matrices produced by serial and parallel for N=10 for a sanity check to confirm coherent results.

serial	N = 10	parallel	N = 10
1.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09		1.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09	
0.01 1.00 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10		0.01 1.00 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10	
0.02 0.03 1.00 0.05 0.06 0.07 0.08 0.09 0.10 0.11		0.02 0.03 1.00 0.05 0.06 0.07 0.08 0.09 0.10 0.11	
0.03 0.04 0.05 1.00 0.07 0.08 0.09 0.10 0.11 0.12		0.03 0.04 0.05 1.00 0.07 0.08 0.09 0.10 0.11 0.12	
0.04 0.05 0.06 0.06 0.99 0.09 0.10 0.11 0.12 0.13		0.04 0.05 0.06 0.06 1.00 0.09 0.10 0.11 0.12 0.13	
0.05 0.06 0.07 0.07 0.08 0.99 0.11 0.12 0.13 0.14		0.05 0.06 0.07 0.07 0.08 1.00 0.11 0.12 0.13 0.14	
0.06 0.07 0.08 0.08 0.08 0.09 0.98 0.13 0.14 0.15		0.06 0.07 0.08 0.08 0.08 0.09 1.00 0.13 0.14 0.15	
0.07 0.08 0.09 0.09 0.09 0.09 0.09 0.97 0.15 0.16		0.07 0.08 0.09 0.09 0.09 0.09 0.09 1.00 0.15 0.16	
0.08 0.09 0.10 0.10 0.10 0.10 0.10 0.09 0.96 0.17		0.08 0.09 0.10 0.10 0.10 0.10 0.10 0.09 1.00 0.17	
0.09 0.10 0.11 0.11 0.11 0.11 0.10 0.10 0.10 0.95		0.09 0.10 0.11 0.11 0.11 0.11 0.10 0.10 0.09 1.00	