ID5130 Parallel Scientific Computing Feb-May 2021

Assignment 3

Assigned: May 4, 2021 Due: May 16, 2021 Max. Marks: 100

General Instructions

- Upload a single PDF file containing all the solutions/plots and any hand-written equations that you have used in developing the programs. For each of the problems/programs that you develop indicate the status of your code as complete/ compiles/ runs/ runs-and-gives-correct-result. Please write your name and roll number on top of the first page of the solution file.
- Upload a single zipped folder containing the codes for all the problems you have solved.
- Both the PDF file containing the solutions and the zipped folder should be uploaded on Moodle only. Emailed submissions will not be graded.

Questions

1. (40 points) Recall the problem statement from Assignment 1 wherein you computed the derivative using tri-diagonal LU decomposition for f(x) = sin(5x). Starting from its serial code, write its corresponding OpenACC program (you do not need to use the recursive doubling approach). Optimize the code to avoid unnecessary data transfer and improve execution time. Plot the analytical and the numerical solution for n = 100 and number of gangs = 10. Plot the time taken by the full parallel solver for n = 1000 for number of gangs = 1000, 100, 10.

2. (60 points) You are given a serial C code that performs Cholesky decomposition, which decomposes a matrix to a tri-diagonal matrix. Thus, given a matrix A[N][N], it outputs a lower-triangular matrix L[N][N] such that $A = LL^T$. The computation is specified as below.

$$\mathtt{L}(i,j) = \begin{cases} i = j & : \sqrt{\mathtt{A}(i,i) - \sum_{k=0}^{i-1} \mathtt{L}(i,k)^2} \\ i > j & : \dfrac{\mathtt{A}(i,j) - \sum_{k=0}^{j-1} \mathtt{L}(i,k)\mathtt{L}(k,j)}{\mathtt{L}(j,j)} \end{cases}$$

The given serial code performs minor adjustments to reduce chances of overflows and underflows. Parallelize the given code using OpenACC ensuring correctness. You are free to modify the code at your will. Optimize for data transfer, parallelism, and number of gangs. Plot the time taken by the serial and the parallel codes for N = 10, 100, 1000 in the same plot.
