HBM 514E PARALLEL NUMERICAL ALGORITHMS & TOOLS

May 09, 2022

# HOMEWORK #2

## Parallel Algorithm Implementation for Direct and Iterative Methods

Suppose that linear set of equations are given by **A x = b**, where **A** matrix is in 50,000 x 50,000 size and symmetric dense matrix (you may use some random matrix generator libraries with desired Condition Number such as http://www.netlib.org/lapack/testing/matgen/). Solve this matrix equation by using the following methods:

***Method 1***: A direct method such as Gauss Elimination or LU Factorization.

***Method 2***: Jacobi iterative method with an Error Value1 = $10^{-4}$ and Value2 = $10^{-7}$.

***Method 3*****:** Gauss-Seidel iterative method with a red-black algorithm (Error Value1 = $10^{-4}$ and Value2 = $10^{-7}$)

Write your parallel programs for above **three methods** using MPI (Message Passing Interface) following the instructions below.

**Instructions:**

1. Test your algorithms for different processor (core) sizes ranging from 1 to 256 with increments by the power of two (i.e., 1, 2, 4, 8, 16, 32, 64, 128, 256). Then, plot a graph showing the number of cores vs. wall clock times for above three methods in a single graph (run your iterative codes for two different error values and compare).

2. Compare Speed Up S(p) and Efficiency E(p) results and discuss the results obtained. Explain the potential reason(s) for a possible weak scalability on the specific processor numbers considering the hardware and software metrics.

3. Compare the numerical methods, and explain the possible improvements obtained by the Method 2 and Method 3 (run your iterative codes for two error values and compare them). What are the potential reasons to obtain the improved results by the iterative methods? Explain.

4. Submit (upload to Ninova system) hard and soft copies of your report (incl. your source codes).

## DUE DATE: May 30, 2022

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