HPC: High-Performance Computing
Academic Year: 2023 - 24

Dr. Praveen Kumar Alapati
praveenkumar.alapati@mahindrauniversity.edu.in
Department of Computer Science and Engineering
Ecole Centrale School of Engineering

Assignment1: Due Date February 13, 2024

Develop parallel codes for the following problems using OpenMP. Report the speedup of your implementations by varying the number of threads from 1 to 16 (i.e., 1, 2, 4, 6, 8, 10, 12, 14, and 16). Use the systems in our IT Lab and consider *gettimeofday*() to measure the runtime of an execution. Repeat the experiment five times and consider the average of five runs. The running time of each run should be reported. Use an Excel workbook with the name TEAMNUM_ASSIGN_NUM.xlsx to maintain all runtimes of your executions. Finally, draw appropriate plots using the GNU plot.

Submission Guide Lines:

- Attach.Name and Type: TEAMNUM_ASSIGN_NUM.zip
- Write a readme file to understand your solutions.
- Submit source files only.

Learn the art of multi-core and many-core programming

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1. **Computer A^2 of a matrix A** for the orders 2048x2048 and 4096x4096. Initialize the elements of the matrix A with random values from the set {-1, 0, 1}. Assume that the matrix is given in row-major order. If you perform any transformation, that also has to be accounted for in the runtime as well. Consider the following implementations to find the A^2,
   - Ordinary Matrix Multiplication (OMM).
   - Block Matrix Multiplication (BMM) using block sizes: 4,8,16,32,64.
2. **N-Queens Problem:** Given an N $\times$ N chessboard and N-Queens. Place N-Queens on the chessboard in non-attackable positions. Consider the different values of N = 12 and 16. Store all the solutions.

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3. **Minimum, Maximum, and Mean:** We have an array of size 2^{28}, and all elements of the array are initialized with random integers from the set $\{0, 1, \ldots, 10^9\}$. Find the minimum, maximum, and mean of all.
4. **Prime Numbers:** Generate all the prime numbers between 2^{40} and 2^{41}.
5. **Dot Product:** Calculate the dot product of two vectors. Assume that the length of each vector is 10^9 and the vectors are initialized with random integers from the set $\{$ -1, 0, 1$\}$.

Verify all your results by using sequential code. If the results are the same, then only we consider the code (or testcase is passed).