

# HPC: High-Performance Computing

## Academic Year: 2023 - 24

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# Submission Guide Lines:

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- ▶ Mail-ID: hpc.mu.2023@gmail.com
- ▶ Sub:ROLLNUM\_ASSIGN\_NUM
- ▶ Attach.Name and Type: (ROLLNUM\_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**

# Assignment 1 (Due Date: September 16, 2023)

Develop a parallel code for the following problem 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 `gettimeofday()` for calculating runtime and consider the average of 5 runs. Finally, draw appropriate plots using the GNU plot. For example

- ▶ Runtime vs. Matrix Sizes by fixing number of threads
- ▶ Runtime vs. Threads by fixing the Matrix Size.

①  **$n^{\text{th}}$  Power of a Square Matrix:** Consider a square matrix A and fill the matrix A (vary the order of matrix from 512x512 to 2048x2048, in powers of 2) with random entries ranging from 0 to 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  $n^{\text{th}}$  Power, vary the value of  $n$  from 2 to 16.

- ▶ Ordinary Matrix Multiplication (OMM).
- ▶ Block Matrix Multiplication (BMM) using block sizes: 4,8,16,32,64.
- ▶ Consider the tranpose of A to find  $n^{\text{th}}$  Power using OMM.
- ▶ Consider the tranpose of A to find  $n^{\text{th}}$  Power using BMM.

- ① For all subproblems, you have calculate  $A^2$ ,  $A^3$ ,  $A^4$ ,  $A^5$ , ...  $A^{16}$  by varying the number of threads: 1, 2, 4, 6, 8, 10, 12, 14, and 16.
- ② You have to repeat the **step1** for different Matrix sizes (i.e., for 512, 1024, 2048).
- ③ For BMM, You have to repeat the **step1** and **step2** for different block sizes (i.e., 4, 8, 16, 32, and 64).