Dept of Computer Science & Engineering
Faculty of Engineering, University of Moratuwa

BSc Engineering, Semester 8

CS4553 Scientific Computing
Assignment 1

Monte Carlo Methods can be used to integrate functions with increasing accuracy, by increasing the number of compute operations. Calculating the value of PI is one example where you can use Monte Carlo Methods.

Part A

1. Use the Monte Carlo method to evaluate the value of constant PI to the following precisions.
    a. 5 decimal points.
    b. 10 decimal points.
    c. 15 decimal points.
    d. 20 decimal points.

    You should experiment with different implementation strategies (pthreads/openmp/CUDA on GPU etc.), and different task decomposition strategies to assess the best timing you can achieve. Justify your choices. Report accurate details on the following aspects of the above tasks for all the strategies you have tried out.

        i. Time spent on the task, and strategy you have used to measure the time.
        j. Strategy you have used to generate random numbers.
        k. Range, precision, and type of random numbers and variables you have used. (Int, float, double etc.)
        l. Task decomposition strategy, including number of threads/processes/kernels and processor assignments, hardware specs etc.
        m. Implementation details

2. Reassess the abovementioned strategies to calculate PI using Monte Carlo Method in terms of number of trials.
    a. 2^{24} Trials
    b. 2^{26} Trials
    c. 2^{28} Trials

    You should report the PI estimation and the error, along with the time consumed in each strategy.

3. Profile the best performing program using appropriate tools. Identify the bottlenecks and report on the most demanding and frequently executed sections of the program.
4. Discuss your findings. What are the limitations of using Monte Carlo Methods?

Part B

5. Calculate the PI using Gregory-Leibniz series instead of Monte Carlo methods with multi-threaded program. Compare and contrast against the Monte Carlo Methods.

   Resources:
   https://www.csc.tntech.edu/pdcincs/resources/modules/plugged/pi_estimation/Pi%20Estimation-Cpp.pdf