ITF23019 - Parallel and Distributed Programming

Course Project

Released date: 11 February 2021

Note:
Each student is free to choose one of the following 10 problems for his/her project. The students then have to register their chosen project in this spreadsheet by **18 February 2021**. Each project can be selected by **AT MOST 3 students**, first come first served.

The score for each part of the problem will be graded based on the code, demonstration, and presentation. **NO written report required.**

During Week 16 and 17, each of you will have about 10 to 15 minutes to present your work.

All aids are allowed including discussion among students. However, copy code or plagiarism is strictly prohibited and students will get zero points if detected.

Students have to commit their codes under **project** directory in their **assigned GitHub repositories**, and **submit in Inspera** by the deadline **(19 April 2021).**

Problem 1: Find all prime numbers from 1 to N where N = 10^8 using Eratosthenes algorithm.

a. Solve the problem using sequential programming (20 pts).
b. Solve the problem using parallel programming (40 pts).
c. Calculate *speedup* and *efficiency* of your parallel algorithm with the number of processors being *p* = 2,4,6, 8, …(20 pts).
d. How the performance of the algorithm changes with *p* (20 pts)?

Problem 2: Calculate Pi number, π, using Simpson's Rule (http://www.mathwords.com/s/simpsons_rule.htm). Simpson's rules: $f(x) = \frac{1}{4+x^2}$; a = 0; b= 1; n = 100000.

a. Solve the problem using sequential programming (20 pts).
b. Solve the problem using parallel programming (40 pts).
c. Calculate *speedup* and *efficiency* of your parallel algorithm with the number of processors is *p* = 2,4,5,8….(20 pts).
d. How the performance of the algorithm changes with *p* (20 pts)?

Problem 3: Sort N (N > 10^6) integer numbers in ascending or descending order using Bucket algorithm. The integer numbers are from an input file.

a. Solve the problem using sequential programming (20 pts).
b. Solve the problem using parallel programming (40 pts)
c. Compare and compare algorithm complexity of the sequential and parallel algorithms (10 pts)
d. Calculate *speedup* and *efficiency* of your parallel algorithm with the number of processors is *p* = 2,4,5,8….(10 pts)
e. How the performance of the algorithm changes with *p* (20 pts)?

Problem 4: Calculate the summation of N (N > 10^6) integer numbers. The integer numbers are from an input file.

a. Solve the problem using sequential programming (20 pts).
b. Solve the problem using parallel programming (40 pts).
c. Calculate *speedup* and *efficiency* of your parallel algorithm with the number of processors is *p* = 2,4,5,8….(20 pts)
d. How the performance of the algorithm changes with *p* (20 pts)?

Problem 5. Suppose that A and B are matrices of size 64x64. Write a parallel program that does matrix multiplication $C = A^T B^T$ where A^T, B^T are transpose matrices of A and B, respectively. Input matrices A, B are from MatrixA.txt and MatrixB.txt files.

a. Solve the problem using sequential programming (20 pts).
b. Solve the problem using parallel programming (40 pts)
c. Calculate *speedup* and *efficiency* of your parallel algorithm with the number of processors is *p* = 2,4,5,8….(20 pts)
d. How the performance of the algorithm changes with *p* (20 pts)?

Problem 6. Finding the maximum/minimum number of an array A[N] (N > 10^6) integer elements with. The integer numbers are from an input file.

a. Solve the problem using sequential programming (20 pts).
b. Solve the problem using parallel programming (40 pts)
c. Calculate *speedup* and *efficiency* of your parallel algorithm with the number of processors is *p* = 2,4,5,8….(20 pts)
d. How the performance of the algorithm changes with *p*? (20 pts)

Problem 7. Find the sums of all the rows of a matrix which has a size of *N* X *M* (*N, M* > 10^3). The matrix is from an input file.

a. Solve the problem using sequential programming (20 pts)
b. Solve the problem using parallel programming (40 pts)
c. Calculate *speedup* and *efficiency* of your parallel algorithm with the number of processors is *p* = 2,4,5,8…. (20 pts).
d. How the performance of the algorithm changes with *p*? (20 pts)

Problem 8. Count the number of unique values in an integer array A[N] (N > 10^6). Values of the array A[N] are from an input file.

a. Solve the problem using sequential programming (20 pts).
b. Solve the problem using parallel programming (40 pts)
c. Calculate *speedup* and *efficiency* of your parallel algorithm with the number of processors is *p* = 2,4,5,8….(20 pts).
d. How the performance of the algorithm changes with *p* (20 pts)?

Problem 9. Given a square matrix A with the size of N (N > 10^3). Calculate the sum of diagonal elements

a. Solve the problem using sequential programming (20 pts).
b. Solve the problem using parallel programming (40 pts).
c. Calculate *speedup* and *efficiency* of your parallel algorithm with the number of processors is *p* = 2,4,5,8….(20 pts).
d. How the performance of the algorithm changes with *p* (20 pts)?

Problem 10. Your own proposal problem with a), b), c) and d) of previous questions. Your own proposal must be approved by the teachers.

(Input files will be provided!)