CSE 6220 / CX 4220 – Introduction to High-Performance Computing – Fall 2024

HW1 - Parallel analysis

Due Monday, January 20, 2025

You should hand in your problem set *online* using Gradescope by 11:59pm on Mon, January 20.

Please write up your assignment using LaTeX and include any collaborators.

You are strongly encourage to be concise in answering homework problems. If you leave a problem blank, you will get 25% of the credit on that problem.

You can find a copy of the CLRS textbook uploaded in Canvas.

Problem 1

The runtimes for solving a problem of size n on p processors are estimated in clock cycles as follows:

Serial runtime $\approx 4n$

Parallel runtime $\approx 8n/p + 1000 \log p$

1. What is the maximum speedup possible as a function of p (consider $n \gg p$)?
2. For n = 2.5 million, what is the largest number of processors that can be used while ensuring efficiency of $1/3$? Approximate calculation is sufficient; for example, $2^{10} \approx 1000$.
3. What is the smallest problem size that must be solved to use 64 processors and achieve efficiency of at least $1/3$?

Problem 2

The best sequential and parallel algorithms for solving a problem have the following runtimes:

$T(n, 1) = \Theta(n)$

$T(n, p) = \Theta(\frac{n}{p} \log n + \log p), \quad p \leq n$

1. What is the maximum efficiency, as a function of n, achievable by this parallel algorithm?
2. What is the maximum number of processors (as a function of n) that can be used while still achieving the maximum possible efficiency?

Problem 3

Solve Exercise 26.1-8 on page 770 in Chapter 26 of CLRS.

Problem 4

Solve Exercise 26.1-9 on page 770 in Chapter 26 of CLRS.

Problem 5

Solve Exercise 26.2-5 on page 775 in Chapter 26 of CLRS.