COSC 462 Fall 2024 : Homework 1

Date: September 16, 2024 **Total points: 25 points** **Due: 5:00 PM, Sept 23, 2024**

Problem 1: Let the strong speedup of a problem of size n that is computationally solved using P processors by a parallel algorithm in time $T(n, P)$ be defined by:

$$S(p) = \frac{T(n, 1)}{T(n, P)}$$

and the efficiency of the same parallel algorithm be defined by:

$$E(p) = \frac{S(p)}{P}$$

Suppose a parallel algorithm has a parallel runtime complexity of:

$$T(n, P) = \Theta\left(\frac{n^2}{P} + \sqrt{n}\right) \qquad \text{for } P \leq n^2$$

(i) (2 points) What is the execution time of this parallel algorithm on a single processor (we assume a single process is mapped to a single processor)?
(ii) (5 points) In terms of n, at what processor count, P_{max}, will the algorithm achieve maximum parallel speedup?
(iii) (3 points) What is the parallel efficiency achieved when P_{max} processors are used?
(iv) (5 points) Maximum parallel efficiency is achieved when $E(P) \sim 1$. At what processor count will this algorithm achieve its maximum parallel efficiency?

Problem 2:
(10 points) The following is a polynomial of a single unknown variable x and degree $n-1$ where $a_0, a_1, \cdots, a_{n-1}$ are known constants.

$$P(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + \cdots + a_{n-1} x_{n-1}$$

The goal here is to compute the value of the polynomial at a given value of x, say, x_0, that is, evaluate $P(x_0)$. Describe step-by-step a parallel algorithm to compute $P(x_0)$. Assume that $n = k_1 p$ and $p = 2^{k_2}$ where k_1 and k_2 are both positive integers greater than 1. What are the parallel computation and communication costs of your algorithm.