- Middle East Technical University  Department of Computer Engineering

CENG 478

Introduction to Parallel Computing

Spring 2019-2020

Assignment 3

Due date: 10.05.2020, 23:59

1. Questions (25 pts each)

   a. Strassen's method [AHU74 , CLR90] for matrix multiplication is an algorithm based on the divide-and-conquer technique. The sequential complexity of multiplying two $n \times n$ matrices using Strassen's algorithm is $\Theta(n^{2.81})$. Consider the simple matrix multiplication algorithm (Section 8.2.1) for multiplying two $n \times n$ matrices using p processes. Assume that the submatrices are multiplied using Strassen's algorithm at each process. Derive an expression for the parallel run time of this algorithm. Is the parallel algorithm cost-optimal? (Problem 8.5)

   b. Figure 8.7 (page 372 of textbook or slide 36 on Lecture 10.pdf) shows that the pipelined version of Gaussian elimination requires 16 steps for a 5×5 matrix partitioned rowwise on five processes. Show that, in general, the algorithm illustrated in this figure completes in $4(n-1)$steps for an $n \times n$ matrix partitioned rowwise with one row assigned to each process. (Problem 8.7)

   c. Show how Dijkstra's single-source algorithm and its parallel formulation (Section 10.3) need to be modified in order to output the shortest paths instead of the cost. Analyze the run time of your sequential and parallel formulations. (Problem 10.2)

   d. Compute the parallel run time, speedup, and efficiency of Floyd's all-pairs shortest paths algorithm using 2-D block mapping on a p-process mesh with store-and-forward routing and a p-process hypercube and a p-process mesh with cut-through routing.

2. Notes

   a. You will submit a pdf or jpeg file via ODTÜClass. It is not important whether you prepare your answers on a digital platform or just on a paper. Just be sure that you fully **explained** your answers and the photo taken is **readable**.

   b. You can still submit your work if the **deadline** is passed, however with an increasing **penalty** of **5*days*days**. (i.e. first day -5 points, second day -5*2*2=-20 points and so on). Note that even a minute late means that it is the other day.

   c. We have zero tolerance policy for cheating. People involved in cheating will be punished according to the university regulations and will get zero.