

## Homework 5: Theory of Performance Engineering

### Introduction

The focus of this problem set is on the theoretical side of the material taught in class and as well serves as a warm-up exercise for the quiz. This problem set should be done *individually*. Please treat it like a take-home quiz. Do not discuss problems with classmates, and clearly cite any external resources you use (e.g., books, published papers, wikipedia).

As preparation for the homework and quiz, read Chapter 27 of Introduction to Algorithms by Cormen, Leiserson, Rivest, and Stein (CLRS).

Please submit a write-up of your answers on the class site.

### 1 Greedy scheduling

**Write-up 1:** Solve Exercise 27.1-3 on Page 791 in Chapter 27 of CLRS.

Ben Bitdiddle measures his deterministic program on 4 and 64 processors on an ideal parallel computer using a greedy scheduler. He obtains running times of  $T_4 = 100$  seconds and  $T_{64} = 10$  seconds.

In the previous problem, we proved that any greedy scheduler schedules a computation with work  $T_1$  and span  $T_\infty$  in time  $T_P \leq (T_1 - T_\infty)/P + T_\infty$  on a  $P$ -processor ideal parallel computer. We also showed in lecture that  $T_P \geq T_1/P$  (Work Law) and  $T_P \geq T_\infty$  (Span Law). Based on these formulas, please answer the following questions.

**Write-up 2:**

1. What is the lowest possible value for the parallelism of the program?
2. What is the highest possible value for the parallelism of the program?

Ben Bitdiddle measures the running time of his deterministic parallel program scheduled using a greedy scheduler on an ideal parallel computer with 4, 10, and 64 processors. Ben obtains the following running times:

$$T_4 : 80$$

$$T_{10} : 42$$

$$T_{64} : 9$$

**Write-up 3:** Argue that Ben messed up at least one of his measurements.

**Write-up 4:** Solve Exercise 27.1-5 on Page 791 in Chapter 27 of CLRS.

## 2 Multithreaded matrix multiplication

**Write-up 5:** Solve Exercise 27.2-5 on Page 796 in Chapter 27 of CLRS.

**Write-up 6:** Solve Exercise 27.2-6 on Page 797 in Chapter 27 of CLRS.

## 3 Multithreading reductions and prefix computations

**Write-up 7:** Solve Problem 27-4 on page 807 in Chapter 27 of CLRS.