Algorithms and Data Structures
Jacobs University Bremen
Dr. Kinga Lipskoch

Course: CH08-320201
March 8th, 2019

Homework 5

- Submit one ZIP file per homework sheet which contains one PDF file (including pictures, computations, formulas, explanations, etc.) and your source code file(s) with one makefile and without adding executable, object or temporary files.
- The implementations of algorithms has to be done using C, C++, Python or Java.
- The TAs are grading solutions to the problems according to the following criteria: https://grader.eecs.jacobs-university.de/courses/320201/2019_1/Grading_Criteria_ADS.pdf

Problem 5.1 *Quicksort with Partition Versions* (10 points)

Implement 3 versions of the Quicksort algorithm with 3 different versions of the partition algorithm:

(a) (2 points) Lomoto partition as on the lecture slides (Lecture 8).

(b) (2 points) Hoare partition (use Wikipedia or other sources).

(c) (2 points) "Median-of-three" partition (use Wikipedia or other sources).

(d) (4 points) Measure the running times of the 3 Quicksort versions from above for the same 100000 randomly generated sequences of fixed length 1000, compute the average running times for each of the 3 versions and compare them. Explain the behaviour of the 3 versions and your observations.

Problem 5.2 *Modified Quicksort* (15 points)

(a) (8 points) Implement a modified version of the Quicksort algorithm, where the sequence of elements is always split into three subsequences by simultaneously using the first two elements as pivots.

(b) (5 points) Determine and prove the best-case and worst-case running time for the modified Quicksort from subpoint (a).

(c) (2 points) Implement a modified version of the Randomized Quicksort algorithm, where the sequence of elements is always split into three subsequences by simultaneously using two random elements as pivots.

Problem 5.3 *Decision Tree* (4 points)

Write a different proof for $\lg n! = \Theta(n \lg n)$ (Lecture 9) without having to use Stirling's formula.

How to submit your solutions

You can submit your solutions via *Grader* at **`https://grader.eecs.jacobs-university.de`** as a generated PDF file and/or source code files.
If there are problems with *Grader* (but only then), you can submit the file by sending mail to `k.lipskoch@jacobs-university.de` **with a subject line that starts with CH08-320201**.

Please note, that after the deadline it will not be possible to submit solutions. It is useless to send solutions by mail, because they will not be graded.

This homework is due by Friday, March 15th, 23:00.