DELFT UNIVERSITY OF TECHNOLOGY
Faculty of Electrical Engineering, Mathematics and Computer Science

TI2306 Algorithm Design
Digital test – part 1 of 2

December 14, 2018, 13.30-15.30

- Usage of the book, notes or a calculator during this test is not allowed.
- This digital test contains 3 questions (worth a total of 10 points) contributing 10/20 to your grade for the digital test. The other digital test contributes the other 10/20 to your grade. Note that the final mark for this course also consists for $\frac{2}{3}$ of the unrounded score for the written exam (if both ≥ 5.0).
- Please answer any questions in clear English.
- Weblab has a copy of these instructions, with some additional information regarding input/output if required.
- The spec tests in WebLab **do not necessarily correspond with your grade** ; your answers will be manually graded.
- There is an API specification of the Java Platform (Standard Edition 8) available at `https://weblab.tudelft.nl/java8/api`.
- If an implementation is asked, please provide the **most efficient** implementation in terms of asymptotic time complexity. Providing a suboptimal implementation can lead to a subtraction of points.
- The material for this tests consists of module 1 and 2 of the course and the corresponding book chapters and lectures.
- Total number of pages (without this preamble): 1.

You are in charge of a large courthouse, specifically in charge of scheduling the cases in the different court rooms. In order to make sure that every case is treated as quickly as possible, the municipality has made a radical decision. The court is now going to be open 24 hours a day. To make sure however that there is enough time for judges to change between cases, *there will be a 1 hour break between two cases in the same courtroom*.

The municipality now asks you the following question: given a sequence of cases C where each case i has a certain time it takes to handle the case t_i and $m \geq 1$ courtrooms available, how many hours do we need to handle all cases **in the given order**?

You may assume all cases are handled in a single sitting and that the case cannot switch courtrooms midway through a sitting.

1. (4 points) Provide an implementation of a method that calculates the number of hours we need (please mind the general instructions on the frontpage of the exam).

   After working with the 24 hours a day solution for several months, judges start to complain that their irregular working times lead to errors in their judgement. They come up with a set of alternative solutions. Every such solution (x, y) has a number of hours x required to schedule all the cases, and a quality y, related to the (preferred) working times for the judges. For this exam we assume there are no two solutions with the same number of hours x.

   We say that a solution (a, b) strictly *dominates* another solution (x, y) if $a < x$ and $b \geq y$; simply put, if (a, b) has fewer hours and no worse quality. For example, $(2, 3)$ dominates $(4, 3)$ and also $(5, 2)$. See also the example in Figure 1 below.

2. (1 point) Provide an efficient implementation of the method `unDominatedBy` which takes a solution (a, b) and an array S as arguments, and returns all solutions from S that are not (strictly) dominated by (a, b).

   Next we are interested in the Pareto-optimal subset of solutions S, i.e., the subset of solutions from S that are not dominated by any other solution in S.

3. (5 points) Provide a divide-and-conquer implementation of the method `getParetoOptima` which returns the Pareto-optimal solutions of an array S.

   Hint: You can outperform an $O(n^2)$ algorithm that compares all pairs of solutions.

   Note: You should design a divide & conquer algorithm that is recursively implemented! If your algorithm does not use the divide & conquer strategy, points *will be* deducted.

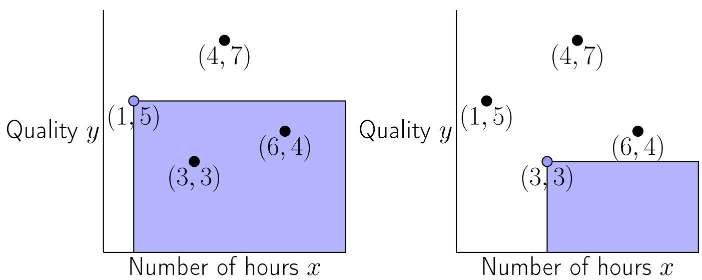

Figure 1: These illustrations show what parts of the solution space are dominated by the highlighted solution. For instance in the left figure we see that $(1, 5)$ dominates both $(3, 3)$ and $(6, 4)$ but not $(4, 7)$. In the right figure we see that $(3, 3)$ does not dominate any other solution (all of them either have fewer hours, or a higher quality).

End of exam questions