Theory exam in DD1352/DD2352 Algorithms (data structures) and complexity
2016-08-17 9.00-11.00

No aids. Write your answers directly on this form. Examiner: Viggo Kann, 08-7906292.

Bonus points from the academic year 2015/2016 can be used for this exam. For grade E, 13 points is needed for the course DD1352 and 12 points for DD2352. If you also pass the grade D question below you will get D, and if you *also* pass the grade C question you will get C. If you would like to take an oral exam next week to get A or B (after passing this written exam), please tick this box: ☐

Name: ..... *Social security number:* .....

1. (8 p) Are the following clauses true or false? Circle the correct answer! For every question, the correct answer will give you 1 point, and a *convincingly motivated* answer will give you 2 points.

   a) $n^2 \in \omega(n \log n)$.

   true **false**

   Motivation:

   b) The expected time complexity of Random Quicksort is $O(n \log \log n)$.

   true **false**

   Motivation:

   c) EXPTIME⊂P

   true **false**

   Motivation:

   d) If the approximation algorithm A approximates a minimization problem within 4 and the optimal value of a certain problem instance is 400, we know that A cannot return a solution with value greater than 1600.

   true **false**

   Motivation:

2. (3 p) A, B, C and D are decision problems. Suppose that B is NP-complete, and that there are known polynomial Karp reductions between the problems in the following way (where a reduction from A to B is shown by an arrow A→B):

$$\begin{array}{ccc} A & \leftrightarrow & B \\ \uparrow & & \uparrow \\ C & \leftrightarrow & D \end{array}$$

What is known about the complexity for A, C and D? Write an X in the table below for everything that is certain, and write a ring for everything that is possible but not certain.

	lies in NP	is NP-complete	is NP-hard
A			
C			
D			

3. a) (2 p) Define the concept *Turing reduction*.

   b) (1 p) Define the complexity class P.

4. (Question for grade D, grading criterion: *explain how problems of high complexity can be handled*)
   Give two different suggestions for how to attack optmization problems where the optimal solution cannot be computed efficiently enough.

   Suggestion 1:

   Suggestion 2:

5. (Question for grade C, grading criterion: *design simple heuristics and exhaustive search algorithms*)
   Give pseudo code for an exponential algorithm that solves the problem Hamiltonial circuit, where the input is an undirected graph with n vertices.