

## Computational Complexity and Heuristic Programming, 2016/17

### Written exam, 01 February 2017

All questions count equally. Literature, electronic and communication devices are not allowed. It is allowed to use up to 2 sheets of A4 format paper with handwritten notes. You can write your answers in Slovene or English. Duration: 90 minutes.

Oral exam for students who wish to improve their grade and have achieved at least 50% of points in written exam, will take place on Monday, 06 February 2017 at 13:00, in the office of Prof Robnik Šikonja (2<sup>nd</sup> floor, room 2.06).

1) Find solutions to the following recurrences.

a)  $T(n) = 8T(n/2) + \sqrt{n}$

b)  $T(n) = T(n-4) + n^3$

$$T(0) = T(1) = T(2) = T(3) = 1$$

2. Consider a random permutation of the numbers 1, 2, ... n. We write an algorithm A which for does the following.

- For each number in this permutation which is greater than all the numbers to its left, it calls a procedure with computational complexity  $\Theta(n^3)$ .
- For each number in this permutation which is not greater than all the numbers to its left it calls a procedure with computational complexity  $\Theta(n)$ .

What is the tight upper bound for computational complexity of algorithm A.

3. Assume you are creating an array data structure that has a fixed size of  $n$ . You want to backup this array after every so many insertion operations. Unfortunately, the backup operation is quite expensive, it takes  $n$  time units to do the backup. Insertions without a backup just take 1 time unit.

How frequently can you do a backup and still guarantee that the amortized cost of insertion is  $O(1)$ ? Justify your answer.

4. A dominating set for a graph  $G = (V, E)$  is a subset  $D$  of  $V$  such that every vertex not in  $D$  is adjacent to at least one member of  $D$ . The domination number is the number of vertices in a smallest dominating set for  $G$ .

Propose a neighbourhood structure for local optimization approach to this problem and propose features which could be used in penalization with guided local search. Suggest contents of tabu lists which could be useful in tabu search. Justify your suggestions.