

09.71.23/24 Tölvunarfræði IIa/II

Final exam

May 8th 2000
14⁰⁰ ? 17⁰⁰

*The first 5 problems are for all students (both from Tölvunarfræði II and IIa) Problem 6 is only for students from Tölvunarfræði II, but problem 7 is only for students in Tölvunarfræði IIa (engineering students). In both cases **five best problems out of six count**.*

All written materials and a calculator allowed.

1. a) Implement the function `concat` with the following header.

```
template <class Object>
void concat( Node<Object> *s, Node<Object> *t )
```

The parameters `s` and `t` are pointers to singly, circularly linked lists with header nodes. The function concatenates the list that `t` points at to the back of the one that `s` points to. After the execution of the function the list that `s` points to should remain a singly, circularly linked list with a header node, but `t` does not point to a legal list any more.

b) Is it possible to do this task faster if the two lists are **doubly**, circularly linked? Explain with words and drawings.

2. Show how to implement two stacks in one vector, such that the memory is utilised in the best possible way. Show pseudocode for the functions `push` and `pop`, that handle the case when the stacks are full.

3. If we have **both** a preorder and a postorder list of the nodes in a binary tree, is there then exactly one binary tree that is consistent with those two lists? In other words, can we find a unique binary tree from a preordering and a postordering of nodes? Show a counter example or a method to find the tree.

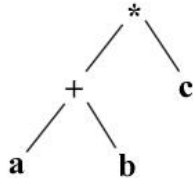
4. a) We are interested in finding the $\log N$ smallest items in an N -item list. One method is to sort the list in increasing order and take the first $\log N$ items. That method has the time complexity $O(N \log N)$. However, it is possible to do better. Describe an $O(N)$ method to solve this problem and give some arguments supporting its time complexity.

b) Is there also a linear method to find the \sqrt{N} (square root of N) smallest items? Show a method or argue that it is not possible

5. Assume that you get an ordered vector of N items that are to be inserted into a binary search tree. If the items were to be inserted in the order that they appear in the vector then the resulting binary search tree would be very unbalanced. Show in which order you would insert the items so that the tree will be as balanced as possible. Describe a method to generate this insertion order from an N item ordered vector.

Only for students in Tölvunarfræði II:

6. In general when expression trees are written out with an infix method then we need to use parenthesis so that the expression is correct. One way is to parenthesize everything in the expression, like $((a+b)*c)$ from the expression tree below. Because of operator precedence and associativity many of the parenthesis are not needed. In the example above it is enough to write $(a+b)*c$.



Describe in detail a method that accepts an expression tree and writes out an expression in infix-form with as few parenthesis a possible. Take into account operator associativity, i.e. whether the operator are left- or right-associative.

Only for students in Tölvunarfræði IIa (engineering students):

7. N items are to be stored in storage containers. Item i has size s_i and each container has size C . The method to be used is called *worst-fit*, which means that at any point in time we put item i into that container that has the most free space out of the ones in use. If the item does not fit into this container (and therefore not into any of the other containers in use) then a new container is taken into use and item i put into it.

Describe the implementation of this method in more detail. List the use of data structures you use to make the method as efficient as possible. What is the time complexity of the method?