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Date: 2026-06-20
Version: 2026-06-20 14:04

Exercise Sheet 10 for Algorithmen und Datenstrukturen (Sommer 2026)

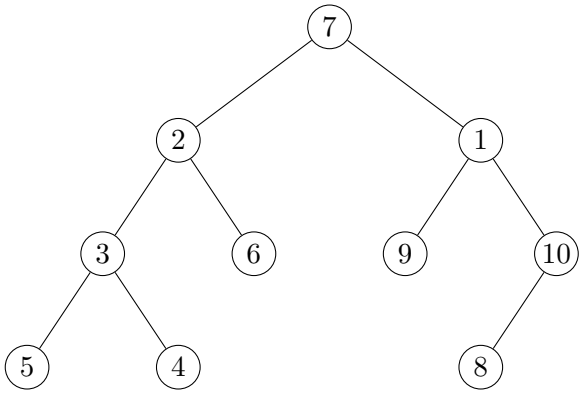
Hand In: *Until 2026-06-27 18:00, on ILIAS.*

Problem 1

5 + 25 points

a) We define the *preorder*, *inorder*, and *postorder* of a binary tree. For a binary tree, the *preorder* of a leaf contains only itself, and the preorder of an internal node puts itself first, then the preorder of its left subtree, then the preorder of its right subtree. The *postorder* of a leaf contains only itself, and the postorder of an internal node puts the preorder of its left subtree first, then the preorder of its right subtree, then the node itself. The *inorder* is similar, but puts the left subtree first, then the node itself, followed by the right subtree.

Consider the following tree (*not* a search tree):



Determine its inorder, preorder and postorder.

b) Suppose you are given a binary tree (not necessarily a search tree) with n vertices. Give a data structure which can answer *ancestor* queries, i.e. "is u an ancestor of v?" Recall that u is an ancestor of v if either $u = v$, or u is an ancestor of the parent of v. Your data structure should be computable in $O(n)$ time, and should answer queries in $O(1)$ time. Give a proof of correctness of the data structure.

Note: Assume that the names (labels) of nodes are distinct integers in the range $1, \ldots, n$. Of course the tree is not necessarily a search tree with respect to these labels.

Problem 2

20 points

Simulate the operation of a 2-3 tree as we insert the following keys into an initially empty 2-3-tree:

$$62, 8, 83, 64, 70, 5, 61, 10, 79, 44.$$

Show your work at suitable intermediate stages of the operations, e.g., how your tree looks like at that point in time.

Problem 3 (Insert-Delete-Access)

40 points

Solve `marburg.kilonova.ro/problems/11` (insDelAcc).

ILIAS Submission: In your submission to ILIAS, describe your algorithm according to the template, *Idea*, *Pseudocode*, *Correctness*, *Analysis*.
The pseudocode part can here an informal summary of your kilonova code submission.