Assignment 3, COMP 251, Feb 12, 2019.

Exercise 1. TREE CONVERSIONS. Consider the Harris walk of an ordered tree on n nodes, i.e., a binary sequence of length $2(n-1)$ denoting the direction of movement when one walks around a tree. From this walk, given in array form, give a linear time algorithm that reconstructs the tree in oldest child / next sibling pointer form.

Exercise 2. RECURSIVE PROGRAMS. In what follows, T is a binary tree. Nodes are denoted by u and v, and the root is r. Left and right children of u are denoted by left$[u]$ and right$[u]$. Each node has an integer "value" val$[u]$. Write top-down $O(n)$ time recursive programs that compute, for all nodes u, the attributes height$[u]$, max$[u]$ and sum$[u]$, where,

(i) height$[u]$ is the maximal distance from u to any leaf in its subtree.

(ii) max$[u]$ is a pointer to the ancestor of u that has the maximal value (among ancestors of u).

(iii) sum$[u]$ is the sum all the values of the nodes in the subtree of u.

Exercise 3. PREORDER AND POSTORDER. An expression tree is a rooted ordered tree in which each internal node corresponds to an operator, which can be binary (+, -, *, etcetera) or unary (negate, cos, exp, sin, tan, etcetera), and each leaf is an operand (a number, say). Its postorder listing is called a postfix expression. An example is

$$ab + cd - *e \cos +$$

which represents the expression

$$((a + b) * (c + d)) + \cos(e).$$

Given an array with a postfix listing of length n, find an $O(n)$ time algorithm that outputs a prefix listing for the same expression. You may assume that for each item in the listing, it is known whether it is a binary operator, a unary operator, or an operand. No recursions please: if necessary, use stacks in an explicit manner.