Algorithm Engineering
Final term – 15 december 2021 – time 60 minutes

Question #1 [scores 3+4]. You are given the binary tree described by the following list of edges (ordered left-to-right for the same parent):

(a,b)(a,c)(c,d)(c,e)(e,f)(e,g)

- Encode the tree using the LOUDS scheme
- Simulate the algorithm that traverses the path "acd" using Rank/Select data structures built on LOUDS.
- Write the pseudocode of an algorithm that taken in input a binary tree T with nodes labeled with letters (possibly repeated among nodes) and represented via LOUDS plus an array L of those letters properly arranged, and taken in input also a letter X and a positive integer d, prints TRUE if there exists a node in T labeled with X and having distance d from the root (where the distance is measured as number of edges). (*hints:* Assume that you have also Rank/Select data structures on LOUDS representation of T.)

Question #2 [scores 5]. Given the following SYMB and FC arrays for a Canonical Huffman code:

SYMB[1] = [], SYMB[2] = [A,B], SYMB[3] = [C,D,E], SYMB[4] = [F,G]
FC = [2, 2, 1, 0]

Decompress the first 2 letters of the following compressed bit sequence: 000111…

Question #3 [scores 5]. Given the string "CABABCA" compress it by using the pipeline BWT + MTF + RLE0 + Huffman, where MTF counts letter's positions from 0, and RLE0 uses the Wheeler's code.

Question #4 [scores 4+4] Given the set of strings

S = {AAAA, AACAAB, AACACC, CA, CB}

- Built the Patricia trie PT for S
- Show the steps executed to lexicographically search for P1 = ABC in the PT

Question #5 [scores 5] Given the following set of strings, each consisting of two digits:

S = {11, 22, 33, 44}

Compute the Minimal Ordered Perfect Hash for S by assuming the following two hash functions:

$h_1(xy) = x+y \mod 7$ and $h_2(xy) = x+2*y \mod 7$

in which x (resp., y) is the first (resp., second) digit of a string of S. As an example, if the string is 11, then x=1 and y=1.