

Algorithm Engineering

Final term – 14 January 2022 – time 75 minutes

Question #1 [scores 5+5]. Given the set S of pairs $\{ \langle 4, D \rangle, \langle 5, B \rangle, \langle 3, A \rangle, \langle 7, F \rangle, \langle 2, E \rangle \}$, where the first component is the key and the second component is the priority:

- Build a TREAP data structure by inserting the pairs in that order (you can assume that it is a MAX heap and letters on the Y-axis are sorted from bottom to top as A, B, C, ...).
- Show and comment how to solve the three-sided range query $[3,6] \times [C, +\infty]$

Question #2 [scores 5]. Given the list of integers $A = \{2, 3, 5, 6, 8, 10, 11\}$, use Interpolative Code and emit the encoding of the “first” three integers 6, 3 and 10.

Question #3 [scores 5]. Given the text $T = \text{aab}$, encode it using Arithmetic Coding and the semi-static model. (Associate the intervals from the bottom to the top as “a”, “b”; and use the fractions directly.)

Question #4 [scores 4+2]. Design a Spectral Bloom Filter of size 7 cells and

- insert the following sequence of keys $\{1,2,3,4\}$ with hash functions $2x \bmod 7$, and $3x \bmod 7$.
- Execute the query on the key 5

Question #5 [scores 4+2] Write the pseudo-code of an algorithm that implements the intersection of two sorted lists L_1 and L_2 of n_1 and n_2 elements, respectively, encoded by Elias-Fano, using the functions ACCESS and GEQ as pre-built:

- $\text{ACCESS}(L,i)$ = returns the i -th element of a list L
- $\text{GEQ}(L,x)$ = returns the position of the smallest element of L which is larger-or-equal than x

Evaluate and comment the time complexity of the proposed solution.