ESO207A: Data Structures and Algorithms
Theoretical Assignment 3

Deadline: March 27, 2018

March 22, 2018

Instruction

- You are advised to solve these without use of the internet.
- All submission must be in the pdf format.
- Please write precise answers, don't write unnecessary details.
- Marks of subparts of questions may not be evenly distributed.

Problem 1. (30 marks) You are given a binary min heap H of size n, a number x, and a positive integer k(less than n). Design an O(k) time algorithm to determine if x is smaller than k^{th} smallest element in H. You may use O(k) extra space.

Problem 2. (20 marks) For following problems provide $O(|V|)$ algorithms,and also justify time complexity.

1. Given undirected graph G=(V,E), find if graph is acyclic (has no cycles).
2. Given undirected graph G=(V,E) find if graph is a tree or not.

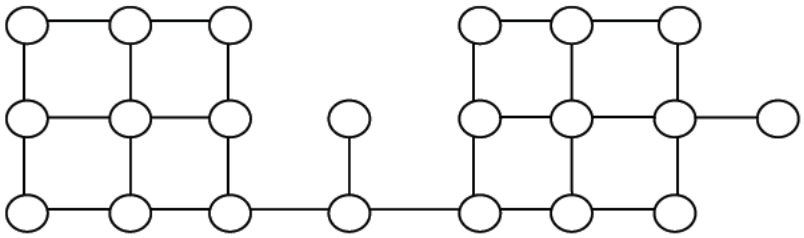
Problem 3. (40 +10 marks) Given a dictionary of words D, where each word is string of English alphabets. Now you have two words A, B, you have to reach from A to B using allowed *edits*. Allowed edits of a word X is all those words Y which belongs to dictionary D and can be reached by single insertion, deletion or replacement of an alphabet from X.

Derive an efficient polynomial time algorithm for printing one of the path with minimum number of allowed edits taken to reach B starting from A. Also provide time complexity analysis of algorithm.
Example: D= {abc,bcd,acd,abd,bcd,bca,bac}, A=abc, B=bcd
Desired path - abc,abd,acd,bcd. Different path with same length is also allowed.

Given each word string has size less than c, and Dictionary size d, find worst case time complexity of your algorithm.

Problem 4. (20 marks) Given 6 integer values and the hash function, h(g)=g mod 10. Hash table is of length 10. The collision resolution technique is Linear Probing. After inserting these 6 values into the hash table, it looks like :
0 - nothing
1 - nothing
2 - 42
3 - 23
4 - 34
5 - 52
6 - 46
7 - 33
8 - nothing
9 - nothing
In how many ways these 6 integers can be inserted one after the other into the hash table? Give proper explanation.

Problem 5. (10 marks) Given the graph below, what is the maximum possible height of the DFS spanning tree. Draw the spanning tree and also explain.



Problem 6. (20 marks) There are a set of islands connected via bridges. Each island is connected to one or more islands. Each bridge has a token associated with it using which a person can walk on that bridge. A token can only be used once. John wants to take up a challenge. He is given one token for every bridge(If there are n bridges, he's given n tokens). Tokens are unique for every bridge i.e., for every bridge he has to use the token corresponding to that bridge only. He wins only if he uses all the tokens that is if he takes all the bridges exactly once. Design an algorithm to find a path which John needs to take to win.