Algorithms and Data Structures, Academic Year 2012/2013

International Bologna Master in Bioinformatics

June 26, 2013

Please complete the following exercises by applying the concepts that have been illustrated to you during the classes. The score associated with each exercise and the expected time for completion is reported in the first line. Do NOT copy/exchange results (the parameters of each exercise are different).

Exercise 0 (2 points): write your name and surname in the first row of all the sheets you use.

Name:_________________________________ Surname:______________________________

Exercise 1 (38 points, 60 minutes): please design the data structures and provide a high level description (e.g. pseudo-code) of the main components of the algorithm that you would implement to efficiently realize a "random walk on a graph" game as follows. A set of N independent threads is executed, and each thread mimics the steps of one person walking randomly over the vertexes of a undirected graph G(V,E) defined as an input of the problem. One thread in vertex V can travel in one step only to one of the randomly selected vertexes directly connected to vertex V in the graph G. Imagine that you stop the execution after some time: your task is to design the graph G and the additional data structures required to efficiently answer to the following questions.

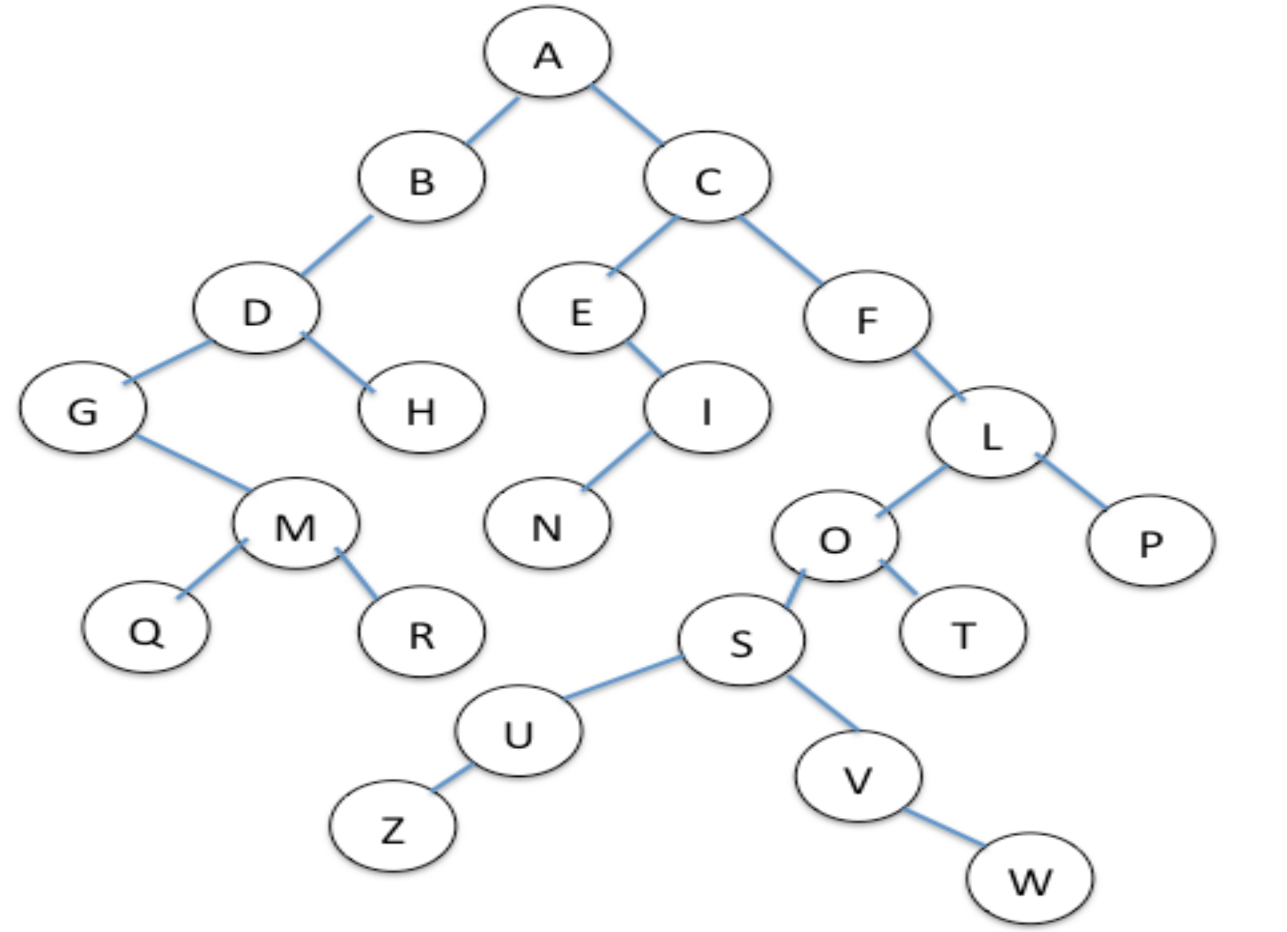
1. How many different vertexes have been traversed by thread X, so far? (input X in [1..N])
2. How many times any vertex V has been cumulatively "visited" by all the walking threads, so far? (input V in G(V,E))
3. Which vertex is the most visited one?

For each implementation of the solutions to the questions above, please provide a motivation for your design, and a sketchy discussion of average/worst-case complexity in space and computation.

(use additional sheets for this exercise, including the back of this sheet)

Name:____________________________________ Surname:__________________________________

Exercise 2 (10 points, 15 minutes): given the following binary tree, write the ordered set of visited nodes in post-order and in-order, respectively.



post-order visit:

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in-order visit:

\- -

Name:________________________________ Surname:_____________________________

Exercise 3 (20 points, 30 minutes): please provide the ordered sequence of visited nodes in a Breadth-First-Search (BFS) visit of the directed graph G, starting from node A, by using the Adjacency Set implementation (also show the Adjacency Set data structure, and plot the graph).

G=(V,E), V={A, B, C, D, E, F, G, H, I, L},
E={(A,B)(A,C)(A,G)(B,C)(B,D)(B,F)(B,H)(C,D)(C,E)(D,E)(D,I)(D,F)(E,L)(E,B)(G,L)(H,C)},

Name:_________________________________ Surname:______________________________

Exercise 4 (20 points, 10 minutes): Demonstrate that 3N^4 is Ω(N^3 log N^3).

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Exercise 5 (10 points, 10 minutes): write the pseudo code of a **recursive** function which returns the value TRUE if the first argument X is EVEN and FALSE if the first argument X is ODD, without using division or multiplication. Comment on the time complexity of the function and discuss the advantage of using a divide et impera or a greedy strategy for the proposed algorithm.

example: f(23) returns FALSE, f(18) returns TRUE.

```
int f(int x)
begin
....
```