Algorithms and Data Structures, Academic Year 2010/2011

International Bologna Master in Bioinformatics

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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 the algorithm that you would implement to efficiently realize a “search all the intersecting segments in a line" function. Imagine a 2D space (a line) with an origin (point 0) and a space metric (coordinates) that identifiy all the points in the line. The portion of line contained between two points is called a segment. The input of the problem is given by two arrays BEGIN[1..N] and END[1..N] of integer values such that BEGIN[i] $\leq$ END[i], i $\in$ [1..N]. The two arrays determine a set of N segments, where segment i is defined by the initial and final coordinates (BEGIN[i], END[i]), i $\in$ [1..N]. Your task is to identify all the segments that have some intersection, and specifically:

1. Return “true” if there is at least a segment which intersects another segment in the array.
2. Return the maximum set of segments which contain a common subsegment (intersection).

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)

Name:_____ Surname:_____

Exercise 2 (10 points, 15 minutes): given the following ordered list of visited nodes, write a binary tree structure which produces the lists below when visited in pre-order and in-order, respectively:

pre-order visit: SOUNDRIGHT!

in-order visit: UODNRSGITH!

Exercise 3 (20 points, 30 minutes): please provide the ordered sequence of visited nodes in a Depth-First-Search (DFS) visit of the directed graph G, starting from node A, by using the Adjacency List implementation (also show the Adjacency List 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 N^3 is Ω(N^2 log N).

Name:_____ Surname:_____

Exercise 5 (10 points, 10 minutes): Which mathematical function is calculated by the following pseudocode when argument x is an integer value >0 (when passed as initial input)?

```
int f(int x)
begin
  if x<2 then return(2^x)
         else
         return(f(x-1)*(f(x-2))
end
```