Foundations of Computer Science (Semester 2) – 2015

Assessed Exercise Sheet 2 – 10% of Continuous Assessment Mark

Deadline : 11pm Sunday 1st February, via Canvas

Question 1 (24 marks)

Suppose you have a series of photograph 1.jpg, 2.jpg, …, N.jpg and wish to store their locations as a doubly linked list as described in the lectures.

Produce a graphical representation for the N = 5 case.

For the general N case, state in words (not pseudocode) an efficient ordered list of operations that will insert an additional photograph x.jpg into the list at a particular given point near the middle.

Suppose the photograph locations were instead stored in a simple array. State in words an ordered list of operations that will insert an additional photograph x.jpg into the array at a particular given point near the middle.

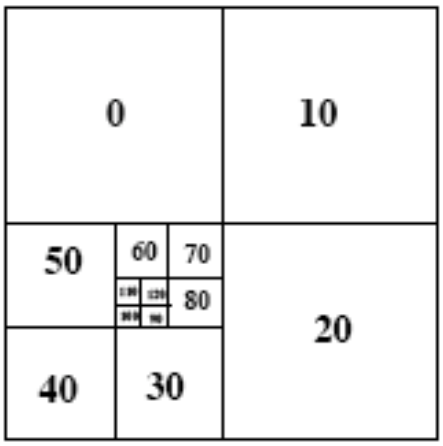
Comment on the different time complexities of the doubly linked list and array versions.

Question 2 (16 marks)

In the lecture notes (section 2.2) we looked at a procedure `last(L)` that returned the last item in the given list `L`. Modify that to create a recursive procedure `getItem(i,L)` that returns item `i` in a list `L`, where `i` is an integer greater than zero.

Question 3 (24 marks)

A *quadtree* was defined in the lectures in terms of primitive constructors `baseQT(value)` and `makeQT(luqt,ruqt,llqt,rlqt)`, selectors `lu(qt)`, `ll(qt)`, `ru(qt)` and `rl(qt)`, and condition `isValue(qt)`. Suppose a gray-scale picture is represented by such a quadtree with values in the range 0…255, for example:



Write a procedure `flip(qt)`, that uses the above primitive quadtree operators, to flip the picture about the horizontal line through its centre.

Write another procedure `avevalue(qt)`, that uses the above primitive quadtree operators, to return the average gray-scale value across the whole picture.

Question 4 (20 marks)

Suppose you already have the primitive binary tree procedures `isempty(bt)`, `root(bt)`, `left(bt)`, and `right(bt)`. Write a procedure `isLeaf(bt)` that returns `true` if the binary tree `bt` is a leaf node, and `false` if it is not.

Then write a recursive procedure `numLeaves(bt)` that returns the number of leaves in the given binary tree `bt`. It is allowed to call any of the primitive binary tree procedures and also your `isLeaf(bt)` procedure.

Question 5 (16 marks)

It is often important to know whether two given binary trees are the same. Write a procedure `equalBinTree(t1,t2)` which returns `true` if the given binary trees `t1` and `t2` are the same, and `false` otherwise. You can assume that you have access to the basic binary tree procedures `isempty(t)`, `root(t)`, `left(t)`, and `right(t)`. [Hint: Remember that you can only directly test the equality of numbers, e.g. node values.]

What is the time complexity of your algorithm?