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國立臺灣大學 114 學年度碩士班招生考試試題

When a question asks for pseudocode, you can use a mixture of English and programming notation to describe your solution. Ensure to provide enough details so that a skilled programmer can readily implement your proposed solution.

1. **(10%)** Write a function in pseudocode that takes an integer, N, as input and returns its binary representation as a string. If N is negative (N < 0), the function should return 'NA'. For example, if N = 5, the function returns '101'.

2. **(10%)** Write a recursive function in pseudocode that takes a reference (or pointer) to the first node of a linked list as argument and returns the value of the maximum key in the list. Assume that the keys in the linked list are all positive integers. If the linked list is empty, the function should return 0.

3. **(10%)** Construct a max-oriented heap by inserting the keys E, A, S, Y, Q, U, E, S, T, I, O, N into an initially empty heap in the given order. Provide the final heap represented as an array after all the keys have been inserted.
   (5%) Determine the time complexity of inserting an element into a max-oriented heap. Specifically, analyze the insertion process, considering how the heap property is maintained after the insertion.
   (5%) Determine the amortized time complexity of inserting an element in to the max-oriented heap when a resized array is used. Assume the following resizing rule: when the array becomes full, it is resized by doubling its current size.

4. **(20%)** Consider two binary search trees, T1 and T2, which contain the same set of keys, {1, 2, …, n}. The goal is to transform T1 to T2 using only rotations. Sketch a general method for doing this, ensuring that the binary search tree property is maintained. Please first clearly define the rotation procedures in your solution.

5. **(15%)** Draw the 2-3 tree that results when you insert the following keys in this order: Y, L, P, M, X, H, C, R, A, E, S. Start with an initially empty tree.

6. **(10%)** Consider a sorted circular doubly-linked list where the head element points to the smallest element in the list.
   a. What is the complexity of determining whether a given element exists in the list?
   b. What is the complexity of deleting a given element e in the list (not including the cost of finding it)?

7. **(15%)** Write a function in pseudocode to calculate the number of leaf nodes of a binary tree. A node in a binary tree has two pointers, named 'left' and 'right', where the 'left' pointer is used to find the left child of the node and the 'right' pointer is used to find the right child. Your function will take a node as the input and return an integer representing the number of leaf nodes in the tree rooted at that node.

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