EECS2011 Assignment 01

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Q1)

Efficiency for each:

A) Array (like the Java array)

(a) Search for an element. -> SLOW

The bigger the array, the more time it will take to search the array. Time complexity of O(n).

(b) Get the middle element, i.e., with the list size being n, return the [n/2]-th element in the list. -> FAST

Time complexity of O(1). No loops are needed, always a constant number of operations.

(c) Insert a new element at the beginning of the list. -> FAST

Need to move all the elements of the array forward by one if the beginning is not null. O(n). However, it's O(1) and extremely fast if the array is empty initially. But we consider the worst-case scenario.

(d) Insert a new element at the end of the list. -> SLOW

Time complexity of O(1), just add the new element to the list, arr[arr.length + 1] = new;

(e) Delete an element from the beginning of the list. -> FAST

Time complexity of O(1), just delete the first element, arr[0] = NULL; This is assuming that we are not required to reorder the array after so that no NULL exists. If that were to be the case, then the time complexity would be O(n) and it would be less scalable – not so fast.

(f) Delete an element from the end of the list. -> SLOW

Time complexity of O(1), just delete the last element, arr[n] = NULL where n is the length of the array.

B) singly-linked list, with "next" only, and with "head" only.

(a) Search for an element. -> SLOW

Time complexity of O(n).

(b) Get the middle element, i.e., with the list size being n, return the [n/2]-th element in the list. -> SLOW

Time complexity of O(n).

(c) Insert a new element at the beginning of the list. -> FAST

Time complexity of O(1). A simple linked list insertion, always a constant # of operations.

(d) Insert a new element at the end of the list. -> SLOW

Time complexity of O(n) since we don't have a "tail."

(e) Delete an element from the beginning of the list. -> FAST

Time complexity of O(1). Just set the second element as the head.

(f) Delete an element from the end of the list. -> SLOW

Time complexity of O(n) since we don't have a "tail."

C. singly-linked list, with "next" only, and with "head" and "tail".

(a) Search for an element. -> SLOW

Time complexity of O(n).

(b) Get the middle element, i.e., with the list size being n, return the ⌊n/2⌋-th element in the list. -> SLOW

Time complexity of O(n).

(c) Insert a new element at the beginning of the list. -> FAST

Time complexity of O(1). A simple linked list insertion, always a constant # of operations.

(d) Insert a new element at the end of the list. -> FAST

Time complexity of O(1). Just insert as the next of the tail, then assign as tail.

(e) Delete an element from the beginning of the list. -> FAST

Time complexity of O(1). Just set the second element as the head.

(f) Delete an element from the end of the list. -> SLOW

Time complexity of O(n) since we don't have a "prev" that we can use to assign the tail after.

D. reverse singly-linked list, with "prev" only, and with "tail" only.

(a) Search for an element. -> SLOW

Time complexity of O(n).

(b) Get the middle element, i.e., with the list size being n, return the ⌊n/2⌋-th element in the list. -> SLOW

Time complexity of O(n).

(c) Insert a new element at the beginning of the list. -> SLOW

Assuming the beginning of the list is where head would be. Time complexity of O(n).

(d) Insert a new element at the end of the list. -> FAST

Time complexity of O(1), just set newNode.prev to the node at tail and set newNode as tail.

(e) Delete an element from the beginning of the list. -> SLOW

Assuming the beginning of the list is where head would be. Time complexity of O(n).

(f) Delete an element from the end of the list. -> FAST

Time complexity of O(1), set the second lastNode.prev as the new tail.

E. doubly-linked list with "next" and "prev", and with "head" and "tail".

(a) Search for an element. -> SLOW

Time complexity of O(n).

(b) Get the middle element, i.e., with the list size being n, return the ⌊n/2⌋-th element in the list. -> SLOW

Time complexity of O(n).

(c) Insert a new element at the beginning of the list. -> FAST

Time complexity of O(1). If currentNode is the head, set currentNode.next.prev as newNode. Set the newNode as head. newNode.prev = NULL; newNode.next = currentNode.next;

(d) Insert a new element at the end of the list. -> FAST

Time complexity of O(1), similar process as above, but reversed for the end.

(e) Delete an element from the beginning of the list. -> FAST

Time complexity of O(1). If currentNode is the head, currentNode.next.prev = NULL; currentNode.next = head;

(f) Delete an element from the end of the list. -> FAST

Time complexity of O(1), similar process as above, reversed.

F. circular singly-linked list, with "next" only, and with "tail" only.

(a) Search for an element. -> SLOW

Time complexity of O(n).

(b) Get the middle element, i.e., with the list size being n, return the ⌊n/2⌋-th element in the list. -> SLOW

Time complexity of O(n).

(c) Insert a new element at the beginning of the list. -> FAST

Time complexity of O(1). -> currentNode = tailNode.next; tailNode.next = newNode; newNode.next = currentNode;

(d) Insert a new element at the end of the list. -> FAST

Time complexity of O(1). New node that is set as the new tail and points to the first node in the list. Also, the old tail node's next is the new node.

(e) Delete an element from the beginning of the list. -> FAST

Time complexity of O(1). currentNode = lastNode.next; lastNode.next = currentNode.next.

(f) Delete an element from the end of the list. -> SLOW

Time complexity of O(n) since there's no "prev." We have to loop through the whole array to point to the last node if we delete the last element.

G. circular doubly-linked list, with "next" and "prev", and with "tail" only.

(a) Search for an element. -> SLOW

Time complexity of O(n).

(b) Get the middle element, i.e., with the list size being n, return the ⌊n/2⌋-th element in the list. -> SLOW

Time complexity of O(n).

(c) Insert a new element at the beginning of the list. -> FAST

Time complexity of O(1). Similar process as with a circular singly-linked list plus assigning the "prev" as it should be assigned. Space complexity is still O(1) but with one more const.

(d) Insert a new element at the end of the list. -> FAST

Time complexity of O(1). Similar process as with a circular singly-linked list plus assigning the "prev" as it should be assigned.

(e) Delete an element from the beginning of the list. -> FAST

Time complexity of O(1). Similar process as with a circular singly-linked list plus assigning the "prev" as it should be assigned.

(f) Delete an element from the end of the list. -> FAST

Time complexity of O(1). If currentNode is the first node in the list: currentNode.prev = lastNode.prev; lastNode.prev.next = currentNode;