CSC148 Worksheet 14 Solution

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Question 1

a.

Operation	**Running time**
Insert at the front of the list	$\mathcal{O}(n)$
Insert at the end of the list	$\mathcal{O}(1)$
Look up the element at index i, where $0 \leq i < n$	$\mathcal{O}(n)$

Correct Solution:

Operation	**Running time**
Insert at the front of the list	$\mathcal{O}(n)$
Insert at the end of the list	$\mathcal{O}(1)$
Look up the element at index i, where $0 \leq i < n$	$\mathcal{O}(1)$

b. The inserting of an element at position i requires $n - i$ elements to be shifted to right.

Using this fact, we can write the Big-Oh expression for inserting an item at index i is $\mathcal{O}(n-i)$.

Question 2

a.

Operation	**Running time**
Insert at the front of the linked list	$\mathcal{O}(1)$
Insert at the end of the linked list	$\mathcal{O}(n)$
Look up the element at index i, where $0 \leq i < n$	$\mathcal{O}(n)$

Correct Solution:

Operation	**Running time**
Insert at the front of the linked list	$\mathcal{O}(1)$
Insert at the end of the linked list	$\mathcal{O}(n)$
Look up the element at index i, where $0 \leq i < n$	$\mathcal{O}(i)$

b. Without the traversal, the running time of inserting is $\mathcal{O}(1)$.

With the traversal, the running time of inserting is $\mathcal{O}(i)$.

Question 3

- Unlike linked lists that store node at different memory location, array-based lists store elements in memory immediately one after another.

  Assuming it's easier for memory to find and perform operations on elements located right after another, I believe it's significantly faster for array-based lists to insert an element at position i.

  Correct Solution:

  Since $n - i = 1,000,000 - 500,000 = 500,000$, we can write $\mathcal{O}(n - i) \approx \mathcal{O}(i)$

  Using this fact, we can conclude the speed of linked lists and array-based lists are roughly about the same.

  Notes:

  - Noticed that professor compared the performance of linked lists and array-based list in terms of Big-Oh.

Question 4

a. When $n = 1$, the total number of nodes traversed is 0. This is because we are only replacing None in *self._first* with *_Node(item)*.

When $n = 2$, the total number of nodes traversed is 0. This is because after adding the first element, we start at *self._first*, and add *_Node(item)* to *self._first.next*.

When $n > 2$, the number of nodes traversed increases by 1 per item added starting with the 3^{rd} element, and this continues until $n-1$ (where it represents the last item in a list). So in this case, the total number of nodes traversed is

$$\sum_{i=2}^{n-1}(i-1) = \sum_{i'=1}^{n-2} i' \tag{1}$$

$$= \frac{(n-2)(n-1)}{2} \tag{2}$$

Correct Solution:

The code for *append* method tells us

```
class LinkedList:
    ...
    def append(self, item: Any) -> None:
        """Append <item> to the end of this list.
        """
        if self._first is None:
            self._first = _Node(item)
        else:
            curr = self._first
            while curr.next is not None:
                curr = curr.next
            curr.next = _Node(item)
```

Listing 1: linked_list.py

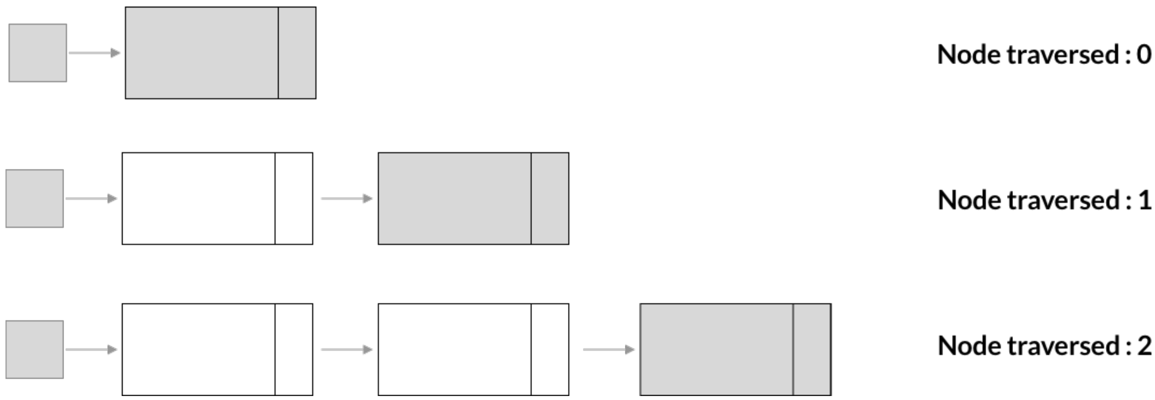
When $n = 1$, the total number of nodes traversed is 0. This is because we are only replacing None in *self._first* with *_Node(item)*.

When $n > 1$, we know the number of nodes traversal required to add an item increases by 1 starting with the 2^{nd} element and this continues until $n-1$ (where it represents the last item in a list). So in this case, the total number of nodes traversed is

$$\sum_{i=1}^{n-1} i = \frac{n(n-1)}{2} \tag{3}$$

Notes:

- I am feeling blue. I feel csc 148 worksheets are designed to be used in class, with details and expectations to questions learned as students are interacting with professor.
- Learned that the number of node traversed means the number of nodes that needs to be traveled to get to the closest None.



b. Since we know from previous problem that the running time of this operation is $\frac{n(n-1)}{2}$, we can conclude its Big-Oh expression is $\mathcal{O}(n^2)$.

Question 5