COP 4538 IT Data Structures (Fall 2021)

Homework 5

DUE: October 25, 11:59 PM

Pair Programming (Group of two)

Q1) The goal of this assignment is to familiarize you with using linked lists (60 Points): To be able to do this assignment, you will be required to understand the node.py class given on canvas. After taking a look at that node.py class please take a look at the a5.py class.

The a5.py contains three important methods:

- Length -> Outputs the length of the linked list
- Insert -> Inserts an element into the linked list
- PrintStructure -> Prints the entire linked list starting from the head

Your task is to fill in these methods given in the a5.py. Hints are given to you inside the a5.py class so make sure to check them out. Note that one of the important concepts in this example is that when a new element is inserted into the list, it gets inserted into it's appropriate (sorted) position. Please take a look at the examples to see how random values are inputted and the result is sorted.

```
Please enter a word (or just hit enter to end): bottle
Please enter a word (or just hit enter to end): a
Please enter a word (or just hit enter to end): water
Please enter a word (or just hit enter to end): of
Please enter a word (or just hit enter to end):
The structure contains 4 items: a bottle of water
```

```
Please enter a word (or just hit enter to end): Ana
Please enter a word (or just hit enter to end): Bill
Please enter a word (or just hit enter to end): car
Please enter a word (or just hit enter to end): algorithm
Please enter a word (or just hit enter to end): button
Please enter a word (or just hit enter to end):
The structure contains 5 items: algorithm Ana Bill button car
```

Grading Metric:

- ➔ **length () method works correctly for our test cases (10 points):**
  - 3-point deduction if it has trouble with several edge cases (at most 2) only but works in general.

➔ **printStructure () method works correctly (10 points):**
- 3-point deduction if it has trouble with several edge cases (at most 2) only but works in general.

➔ **Insert () method works correctly (40 points):**
- 10-point deduction if an item needs to be inserted into the head but cannot be inserted (while there are elements already inserted).
- 10-point deduction if the new node cannot be added to the empty list.
- 10-point deduction if an item cannot be inserted into the middle of the linked list.
- 10-point deduction if an item cannot be inserted into the last element of the linked list.

Q2) Linked-Lists and Sorting [40pt]

Create an algorithm that can sort a singly-linked-list with Merge-sort. Your program should read integers from file (hw5-2.txt) and create an unsorted singly-linked list. Then, the list should be sorted using merge sort algorithm.

The mergesort function should take the head of a linked list, and the size of the linked list as parameters. The mergesort algorithm will be checked for plagerism, so **DO NOT COPY-PASTE** code from the internet or any peers.

a) Unoriginal work will result in a score of 0
b) Read from the provided file **(10pt)**
c) Stores the contents of the files to an unsorted, singly-linked list of INTEGERS **(10pt)**
d) Sort all elements in the list in ascending order using merge sort **(20pt)**

Extra Credit: Linked-Lists [15 pt]

Assume that you want to implement binary search with a linked list. What would be the performance of this algorithm? Compare and contrast this algorithm with the implementation of binary search on traditional sorted array and give a discussion. Your discussion and analysis must explain what the possibilities, issues and consequences of such design are, and then explain whether these issues would exist in the traditional array approach. Your answer can be around 1-2 paragraph of writing backed-up with algorithmic arguments (e.g., access time, steps in algorithms etc…).

Submission:

1. "a5.py" – provided python file with appropriate code added.
2. "hw5-2.py" – python file for the question 2.
3. (Optional) "hw5-extra" – PDF or Word Document containing answer to the extra-credit question.