

EECS2040 Data Structure Hw #3 (Chapter 4 Linked List)

due date 4/18/2022

Format: Use a text editor to type your answers to the homework problem. You need to submit your HW in an HTML file or a DOC file named as **Hw3-SNo.doc** or **Hw3-SNo.html**, where SNo is your student number. Submit the **Hw3-SNo.doc** or **Hw3-SNo.html** file via eLearn. Inside the file, you need to put the **header and your student number, name (e.g., EECS2040 Data Structure Hw #3 (Chapter 4 of textbook) due date 4/18/2022 by SNo, name)** first, and then the **problem** itself followed by your **answer** to that problem, one by one. The grading will be based on the correctness of your answers to the problems, and the **format**. Fail to comply with the aforementioned format (file name, header, problem, answer, problem, answer,...), will certainly degrade your score. If you have any questions, please feel free to ask me.

Part 1 (2% of final Grade, due 4/18/2022)

1. (30%) Given a template linked list **L** instantiated by the Chain class with a pointer **first** to the first node of the list as shown in Program 4.6 (textbook). The node is a ChainNode object consisting of a template data and link field.

```
template < class T > class Chain; // 前向宣告

template < class T >
class ChainNode {
friend class Chain <T>;
private:
    T data;
    ChainNode<T>* link;
};

template <class T>
class Chain {
public:
    Chain( ) {first = 0;} // 建構子將 first 初始化成 0
    // 鏈的處理運算
    .
    .
private:
    ChainNode<T>* first;
}
```

- (a) **Formulate an algorithm** (pseudo code OK, C++ code not necessary) which will count the number of nodes in L. Explain your algorithm properly (using either text or graphs).
- (b) **Formulate an algorithm** that will change the data field of **the kth node** (the first 1st node start at index 0) of L to the value given by Y. Explain your algorithm properly (using either text or graphs).
- (c) **Formulate an algorithm** that will perform an **insertion** to the **immediate before of the kth node** in the list L. Explain your algorithm properly (using either text or graphs).
- (d) **Formulate an algorithm** that will **delete every other node** of L beginning with node first (i.e., the first, 3rd, 5th,...nodes of L are deleted). Explain your algorithm properly (using either text or graphs).
- (e) **Formulate an algorithm** **divideMid** that will divides the given list into two sublists of (almost) equal sizes. Suppose myList points to the list with elements 34 65 27 89 12 (in this order). The statement:
myList.divideMid(subList); divides myList into two sublists: myList points to the list with the elements 34 65 27, and subList points to the sublist with the elements 89 12. Formulate a step-by-step algorithm to perform this task. Explain your algorithm properly (using either text or graphs).
- (f) **Formulate an algorithm** that will **deconcatenate** (or **split**) a linked list L into two linked list. Assume the node denoted by the pointer variable split is to be the first node in the second linked list. Formulate a step-by-step algorithm to perform this task. Explain your algorithm properly (using either text or graphs).
- (g) Assume L₁ and L₂ are two chains: L₁ = (x₁,x₂,...,x_n) and L₂ = (y₁,y₂,...,y_m), respectively. **Formulate an algorithm** that can **merge** the two chains together to obtain the chain L₃ = (x₁,y₁,x₂,y₂,...,x_m,y_m,x_{m+1},...,x_n) if n>m and L₃ = (x₁,y₁,x₂,y₂,...,x_n,y_n,y_{n+1},...,y_m) if n<m. Explain your algorithm properly (using either text or graphs).

2. (55%) Given a **circular linked list L** instantiated by class CircularList containing a private data member, **first** pointing to the first node in the circular list as shown in Figure 4.14.

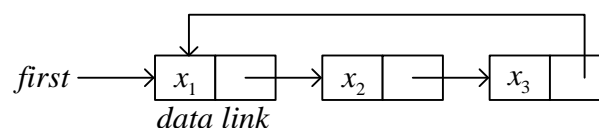


Fig. 4.14 A circular linked list

formulate algorithms (pseudo code OK, C++ code not necessary) to

- (a) count the number of nodes in the circular list. Explain your algorithm properly (using either text or graphs)
- (b) insert a new node at the front of the list. Discuss the time complexity of your algorithm. Explain your algorithm properly (using either text or graphs)
- (c) insert a new node at the back (right after the last node) of the list. Discuss the time complexity of your algorithm. Explain your algorithm properly (using either text or graphs)
- (d) delete the first node of the list. Discuss the time complexity of your algorithm. Explain your algorithm properly (using either text or graphs)
- (e) delete the last node of the list. Discuss the time complexity of your algorithm. Explain your algorithm properly (using either text or graphs).
- (f) Repeat (a) – (e) above and (b) – (g) in Problem 1 above if the circular list is modified as shown in Figure 4.16 below by introducing a dummy node, header.

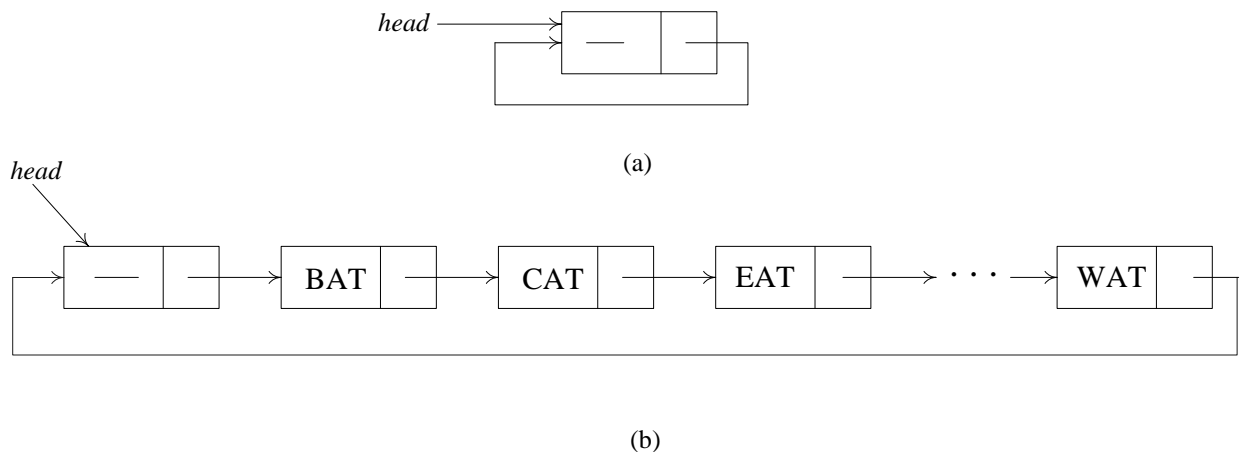


Figure 4.16 Circular list with a header node

3. (15%) The class `List<T>` is shown below,

```
template <class T> class List;
template <class T>
class Node{
    friend class List<T>;
private:    T data;
           Node* link;
};
template <class T>
```

```

class List{
public:
    List(){first = 0;}
    void InsertBack(const T& e);
    void Concatenate(List<T>& b);
    void Reverse();
    class Iterator{
        ....
    };
    Iterator Begin();
    Iterator End();
private:
    Node* first;
};

```

- (a) Implement (pseudo code or C++) the stack data structure as a derived class of the class List<T>.
- (b) Implement (pseudo code or C++) the queue data structure as a derived class of the class List<T>.
- (c) Let x_1, x_2, \dots, x_n be the elements of a List<int> object. Each x_i is an integer. Formulate an algorithm (pseudo code OK, C++ code not necessary) to compute the expression $\sum_{i=1}^{n-5} (x_i \times x_{i+5})$