Lab 1
Linked List

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Note

After completed this tutorial, you can implement a list ADT with linked list. Please review Generic before starting this tutorial.

Part I
Classwork

In this part, lecturer will:

- Summarize the theory related to this lab.
- Instruct the lesson in this lab to the students.
- Explain the sample implementations.

Responsibility of the students in this part:

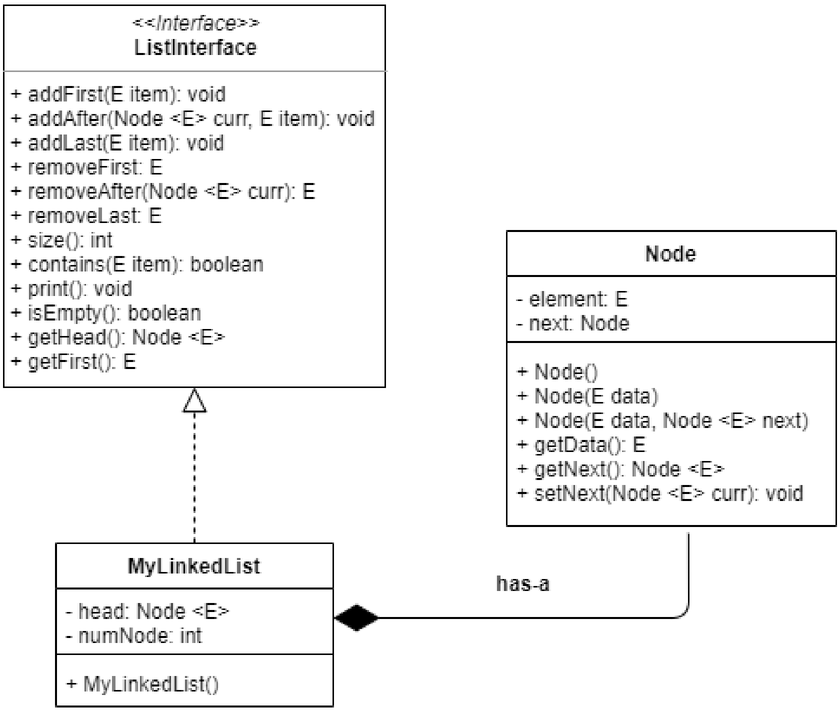
- Students practice sample exercises with solutions.
- During these part, students may ask any question that they don't understand or make mistakes. Lecturers can guide students, or do general guidance for the whole class if the errors are common.

1. UML model of Linked list

The following figure presents an UML model of linked list:

- ListInterface represents public functions of linked list, e.g., add new item, remove an item.
- Node class represents an item (node) in linked list.
- MyLinkedList class implements ListInterface and includes items have Node types.

In the next section, we will approach how to implement a linked list based on the above UML model.



2. *Node* class

Node is the basic item in list, thus we need to implement it first.

```java
public class Node <E> {
    private E data;
    private Node <E> next;
    public Node(){
        data = null;
        next = null;
    }
    public Node(E data){
        this(data, null);
    }
    public Node(E data, Node <E> next){
        this.data = data;
        this.next = next;
    }
    public Node <E> getNext(){
        return next;
    }
    public E getData(){
        return data;
    }
    public void setNext(Node <E> n){
        next = n;
    }
}
```

3. *ListInterface* interface

ListInterface defines the operations (methods) we would like to have in a List ADT.

```
import java.util.NoSuchElementException;
public interface ListInterface <E> {
    public void addFirst(E item);
    public void addAfter(Node <E> curr, E item);
    public void addLast(E item);

    public E removeFirst() throws NoSuchElementException;
    public E removeAfter(Node <E> curr) throws NoSuchElementException;
    public E removeLast() throws NoSuchElementException;

    public void print();
    public boolean isEmpty();
    public E getFirst() throws NoSuchElementException;
    public Node <E> getHead();
    public int size();
    public boolean contains(E item);
}
```

4. *MyLinkedList* class

This *MyLinkedList* class will implement the *ListInterface* interface.

```
import java.util.NoSuchElementException;
public class MyLinkedList <E> implements ListInterface<E> {
    private Node <E> head;
    private int numNode;
    public MyLinkedList(){
        head = null;
        numNode = 0;
    }
    @Override
    public void addFirst(E item){
        head = new Node<E>(item, head);
        numNode++;
    }
    @Override
    public void addAfter(Node<E> curr, E item){
        if(curr == null){
            addFirst(item);
        }
        else{
            Node<E> newNode = new Node<E>(item, curr.getNext());
            curr.setNext(newNode);
            numNode++;
        }
    }
    @Override
    public void addLast(E item){
        if(head == null){
            addFirst(item);
```

```java
        }
        else{
            Node<E> tmp = head;
            while(tmp.getNext() != null){
                tmp = tmp.getNext();
            }
            Node<E> newNode = new Node<E>(item, null);
            tmp.setNext(newNode);
            numNode++;
        }
    }
    @Override
    public E removeFirst() throws NoSuchElementException{
        if(head == null){
            throw new NoSuchElementException("Can't remove element from an empty list");
        }
        else{
            Node<E> tmp = head;
            head = head.getNext();
            numNode--;
            return tmp.getData();
        }
    }
    @Override
    public E removeAfter(Node<E> curr) throws NoSuchElementException{
        if(curr == null){
            throw new NoSuchElementException("Can't remove element from an empty list");
        }
        else
        {
            Node<E> delNode = curr.getNext();
            if(delNode != null) {
                curr.setNext(delNode.getNext());
                numNode--;
                return delNode.getData();
            }
            else{
                throw new NoSuchElementException("No next node to remove");
            }
        }
    }
    @Override
    public E removeLast() throws NoSuchElementException
    {
        if(head == null){
            throw new NoSuchElementException("Can't remove element from an empty list");
        }
        else{
            Node<E> preNode = null;
            Node<E> delNode = head;
            if(delNode.getNext() == null){
                return removeFirst();
            }
            while(delNode.getNext() != null){
                preNode = delNode;
                delNode = delNode.getNext();
            }
            preNode.setNext(delNode.getNext());
            numNode--;
            return delNode.getData();
        }
    }
    @Override
    public void print(){
        if(head != null){
            Node<E> tmp = head;
            System.out.print("List: " + tmp.getData());
            tmp = tmp.getNext();
            while(tmp != null)
            {
            System.out.print(" -> " + tmp.getData());
            tmp = tmp.getNext();
            }
            System.out.println();
        }
        else{
            System.out.println("List is empty!");
        }
    }
    @Override
    public boolean isEmpty(){
        if(numNode == 0) return true;
        return false;
    }
    @Override
    public E getFirst() throws NoSuchElementException{
        if(head == null){
            throw new NoSuchElementException("Can't get element from an empty list");
        }
        else{
            return head.getData();
        }
    }
    @Override
    public Node<E> getHead(){
        return head;
    }
    @Override
    public int size(){
        return numNode;
    }
    @Override
    public boolean contains(E item){
        Node<E> tmp = head;
        while(tmp != null){
            if(tmp.getData().equals(item))
```

```
                return true;
            tmp = tmp.getNext();
        }
        return false;
    }
}
```

5. Test Integer Linked List

```
public class Test {
    public static void main(String[] args)
    {
        MyLinkedList<Integer> list = new MyLinkedList<Integer>();
        list.addFirst(new Integer(2));
        list.addLast(new Integer(3));
        list.print();
    }
}
```

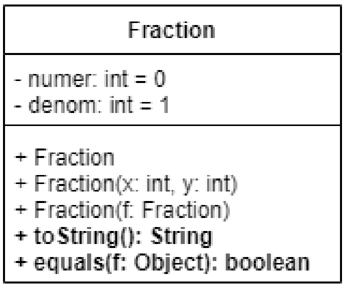
Part II
Excercise

Responsibility of the students in this part:

- Complete all the exercises with the knowledge from **Part I**.
- Ask your lecturer if you have any question.
- Submit your solutions according to your lecturer requirement.

Exercise 1

Giving **Fraction** class as the following class diagram:



Fraction

- numer: int = 0
- denom: int = 1

+ Fraction
+ Fraction(x: int, y: int)
+ Fraction(f: Fraction)
+ toString(): String
+ equals(f: Object): boolean

You need to implement a linked list to contain Fraction items.

Exercise 2

Suppose that we have an abstract method with signature as follow:

public E removeCurr(Node<E> curr)

This method removes the node at position *curr*. You need to add this abstract method to your program and implement it.

Exercise 3

Suppose we are having a list of integer numbers *(You can define a new list with Integer and inherit from the class MyLinkedList above)*, do the following requirements:

(a) Count the number of even item in the list.

(b) Count the number of prime item in the list.

(c) Add item X before the first even element in the list.

(d) Find the maximum number in the list.

(e) (*) Reverse the list without using temporary list.

(f) (*) Sort the list in ascending order.

Exercise 4

Define the interface called DoubleListInterface with common methods such as add, remove, find, etc. Implement the interface using class **MyDoubleLinkedList**, which consists of **DoubleNode** containing the data in primitive data type ***double***.

– THE END –