Lab 5
Review

Quang D. C.
dungcamquang@tdtu.edu.vn

October 09, 2023

Note

In this tutorial, we will review Linked List, Stack, Queue, Recursion and Sorting to prepare for the midterm examination.

In this Lab, lecturer will:

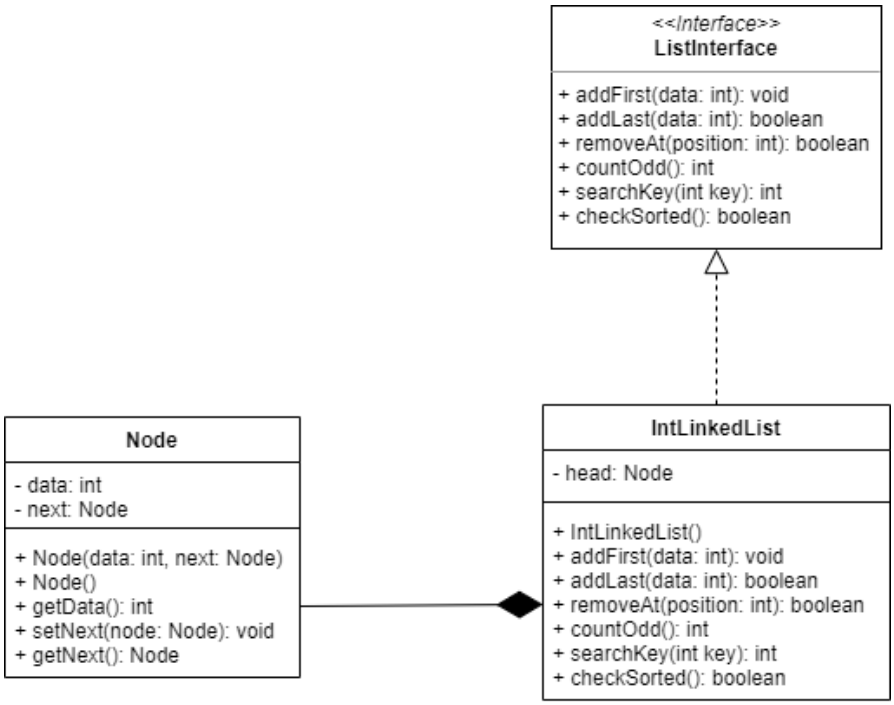
- Summarize the theory related to Linked List, Stack, Queue, Recursion and Sorting.
- Review the important knowledge for the students.

Responsibility of the students in this Lab:

- Complete all the exercises.
- Ask your lecturer if you have any question.
- Submit your solutions according to your lecturer requirement.
- Well prepare for the midterm examination.

1. Linked List

Implementing the integer Linked List following the class diagram:



(a) Method **public void addFirst(int data)**: add the new node contains *data* to the head of the linked list.

(b) Method **public boolean addLast(int data)**: this method first checks if the entered *data* already existed in the the linked list then return *false*. Otherwise, this method will add the new node as the last element of the linked list and return *true* if the node is added successfully.

(c) Method **public boolean removeAt(int position)**: if the *position* value is larger than the number of nodes in the linked list, this method will return *false*, if not, this method will remove the element at the position given by the paramater and return *true* if the node is removed. *(position 1 is the head of linked list)*

(d) Method **public int countOdd()**: return how many odd numbers there are in the linked list.

(e) Method **public int searchKey(int key)**: return the **position** of the node which contains the *key* value. If there are no elements with the *key* value, the method will return **-1**. *(position 1 is the head of linked list)*

(f) Method **public boolean checkSorted()**: return *true* if the linked list is sorted in ascending or descending order, if not, return *false*.

2. Stack and Queue

In this section, you are allowed to use Java API. You can create a Stack easily by import package ***java.util.Stack***. To create a new Stack object:

Stack<E> stack = new Stack<E>();

Example: You can try an Integer stack following this code:

```
import java.util.Stack;

public class Test{
    public static void main(String[] args) {
        Stack<Integer> intStack = new Stack<Integer>();
        intStack.push(2);
        intStack.push(5);
        intStack.push(1);
        while(!intStack.isEmpty()){
            System.out.print(intStack.pop() + " ");
        }
    }
}
```

Exercise 1

To convert an infix expression into a postfix expression, we use the algorithm following the pseudocode:

```
InfixToPostfix(String s)
Create an empty result_string
Split s into the array split_ch
for ch : split_ch do
    if ch is an operand then
        add it to the postfix expression
    else if ch is a "(" then
        push ch into the stack
    else if ch is a ")" then
        push ch into the stack
        repeatedly pop the stack and add to the postfix expression until a "(" is
        found
    else if ch is an operator then
        repeatedly pop the operator from stack which has higher or equal
        precedence than/to the operator found, and add the popped operator to
        the postfix expression
        push ch into stack
while stack is not empty do
    pop stack and add to the postfix expression
return the result_string
```

Implement a function using **Stack** to convert an infix expression into a postfix expression.

Exercise 2

We will use Stack<String> or Stack<Character> to solve this exercise. Giving an infix:

((9 - 2) * 6 + 7) / 7

We can transform to postfix:
9 2 - 6 * 7 + 7 /

Implement a function using **Stack** to calculate the result from the postfix expression. This is the pseudocode (Student can use the result from the above exercise to test this exercise):

```
CalculatePostfixExpression(String s)
Split s into the array split_ch
for ch : split_ch do
    if ch is an operator then
        a ←pop first element from stack
        b ←pop second element from the stack
        res ←b "operator" a
        push res into the stack
    else if ch is an operand then
        add ch into the stack
return element of stack top
```

Exercise 3

Using a **Stack** and a **Queue** to check a positive integer number n is palindrome or not. (*Examples of the palindrome number: 101, 256652, 1221, 121*)

Exercise 4

Using a **Stack** to reverse a sentence. Example input is a sentence: "I like apple" and the output is "apple like I". You must split the string and use **Stack<String>** to solve this exercise.

3. Recursion

Exercise 1

(a) Implement function **public static double prod_recur(int a, int b)** to calculate product of 2 numbers using recursion.

(b) Implement function **public static int bin2dec(int n, int exp)** to convert a binary number (in decimal number form) to decimal number using recursion. Ex: Given n = 1000, bin2dec(n, 0) = 8

(c) Implement function **public static int maxDigit(int n)** to find the largest digit in a positive integer **n** using recursion.

(d) Implement function **public static int maxElement(int a[], int n)** to find the largest element in an array **a** using recursion. When calling this function, use the statement: *maxElement(a, a.length - 1)*.

(e) Implement function **public static int search(int a[], int n, int key)** to find the position of the *key* in an array **a**, if *key* is not in the array, return -1, using recursion. Suppose that, all keys in the array are unique. When calling this function, use the statement: *search(a, a.length - 1, key).*

(f) Implement function **public static int findLastEvenPosition(int a[], int n)** to find the position of the last even element in an array **a**, if there is not exist any even number in array, return -1, using recursion. When calling this function, use the statement: *findLastEvenPosition(a, a.length - 1).*

Exercise 2

Solve this exercise in 2 ways, using recursion and using iteration

(a) $\sum_{i=1}^{n}(2^i)$

(b) $\sum_{x=0}^{n}(\frac{x+1}{2})$

(c) $\sum_{i=1}^{n}(\frac{i!}{(i-1)!})$

(d) $\sum_{x=1}^{n}(x*(x-1))$

(e) $\prod_{x=1}^{n}(x)$

Exercise 3

For each sub-exercise below, define **2 functions**, **one uses recursion** to solve and **the other uses iteration** to solve:

(a)

$$A(n) = \begin{cases} 2, & n = 0 \\ 2 - \frac{1}{2}A(n-1), & n > 0 \end{cases}$$

(b)

$$A(n) = \begin{cases} 1, & n < 10 \\ 1 + A(n/10), & n \geq 10 \end{cases}$$

(c)

$$A(n,k) = \begin{cases} \text{n}, & k = 1 \\ n + A(n,k-1), & k > 1 \end{cases}$$

(d)

$$F(n) = \begin{cases} 0, & \text{n} = 0 \\ 1, & \text{n} = 1 \\ F(n-1) + F(n-2), & \text{otherwise} \end{cases}$$

4. Sorting

Implement **Selection Sort**, **Bubble Sort** and **Insertion Sort** to sort an array in ascending order and follow this rules:

1. Selection Sort: choose minimum element
2. Bubble Sort: ”bubbling up” the largest element to the right partition of the array
3. Insertion Sort: insert the number to the left partition of the array

THE END