Lab 3: Singly Linked-List

Objective(s)

- Introduce the linked list.
- Advantages of Linked List.
- Need of Linked List
- How to Create Linked List in Java.
- How to deal with Linked List in case of: insertion, Deletion, searching.

Tool(s)/Software

Java programming language with NetBeans IDE.

Description

Advantages of Linked List

- Linked List is Dynamic Data Structure. Linked List can grow and shrink during run time.
- Insertion and Deletion Operations are Easier
- Efficient Memory Utilization,i.e. no need to pre-allocate memory
- Linear Data Structures such as Stack, Queue can be easily implemented using Linked list

Need of Linked List

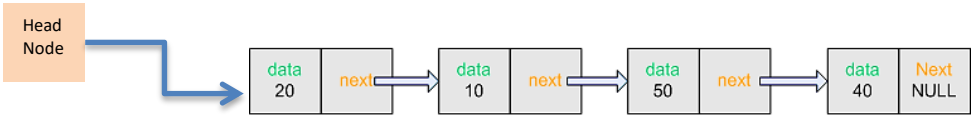
- Suppose you are writing a program which will store marks of 100 students in math. Then our logic would be like this during compile time –
  - **int marks[100];**
- Now at run time i.e. after executing program if number of students are 101 then how you will store the address of 101th student?
- Or if you need to store only 40 students then again you are wasting memory unnecessarily.
- Using linked list, you can create memory at run time or free memory at run time so that you will able to fulfill your need in efficient manner

What's Linked-List?

- A linked data structure consists of capsules of data known as *nodes* that are connected via *links*
  - Links can be viewed as arrows and thought of as one-way passages from one node to another

- In Java, nodes are realized as objects of a node class
  - The data in a node is stored via instance variables

- The links are realized as references
  - A reference is a memory address, and is stored in a variable of a class type
  - Therefore, a link is an instance variable of the node class type itself



How to Create Linked-List in Java

There are **3-steps** approach to create Linked-List in Java

Step 1: Declare class for the **Node** – forming the structure of the node

```
private static class Node<E>{
    private E element;
    private Node<E> next;
    public Node(E e, Node<E> n){
        this.element = e;
        this.next = n;
    }
    public E getElement(){
        return this.element;
    }
    public Node<E> getNext(){
        return this.next;
    }
    public void setNext(Node<E> n){
        this.next=n;
    }
}
```

Step 2: Declare the **SinglyLinkedList** class that includes the Node class.

```
public class SinglyLinkedList<E> {

    // local class for Node with <E>,a generic
    private static class Node<E>{...18 lines }
    //instance variables of the singlyLinkedLis
    private Node<E> head = null;
    private Node<E> tail = null;
    private int size = 0;
    public SinglyLinkedList(){}

    //Access methods
    public int size(){...3 lines }
    public boolean isEmpty(){...3 lines }
    public E first(){...4 lines }
    public E last(){...4 lines }
    public void display(){...11 lines }
    public void find(E e){...11 lines }

    //Update methods
    public void addFirst(E e){...6 lines }
    public void addLast(E e){...8 lines }
    public E removeFirst(){...9 lines }
```

Display Method:

```
void display()
{
    if(isEmpty())
    {System.out.println("Empty List.."); return;}

    Node<E> current=head; int counter=1;
    while(current!=null)
    {
        System.out.print("Node#"+counter+": "+current.element+"   ");
        current=current.next;
        counter++;
    }
}
```

Step 3: Define an object of **SinglyLinkedList** class

```
SinglyLinkedList myList=new SinglyLinkedList();
myList.addFirst("IAU");
myList.addFirst(2322);
```

Note: *Please refer to lecture slides for the algorithms of the main operations on linked list.*

Tasks/Assignments(s)

1. Create SinglyLinkedList for students (id, name). Apply all the following operations as discussed in the lecture:
   - **addFirst**: to add new node to the beginning of the linked list.
   - **addLast**: to add new node to the end of the linked list.
   - **addNode**: to add new node to a specific position in the linked list.
   - **removeFirst**: to remove the first node in the linked list.
   - **findNode**: to find a node with specific given value.
   - **removeNode**: to remove a specific node from the list.
   - **addAfter**: which takes two parameters (Node v, int key). Node v will be added after the node with an **id=key**. If the key wasn't found display *("error, no node has the given id").*
   - **displayList:** to print all Nodes data.
   - **First:** to print first node data.
   - **Last:** to print last node data.

2. (**HW**) Add a Person class that holds the name and address of a person with accessor and mutator methods. Then, test the class by creating a linked list of Person objects. Add and remove objects from the linked list using linked-list operations defined in Task 1.

Extra Task1:

Assume that you are a member in teamwork whose are developing IAU student management system and students' data need to be structured and stored as a list, this list consumes the memory (No wastage of memory size), not important if the list lacks random access for students' data, and easily for addition and deletion (a SinglyLinkedList). Apply all the following operations:

1. Fill the list with the following students using **addFirst**.
   101 Mia
   102 Alice
   103 Ellie
   104 Ruby
2. Display the list using **displayList**.
3. Remove the first student using **removeFirst**.
4. Display the list using **displayList**.
5. Add the following student:
   105 Chloe - after student 102 using **addAfter.**
6. Display the list using **displayList**.

```
-- The list --
104 Ruby
103 Ellie
102 Alice
101 Mia

-- The list --
103 Ellie
102 Alice
101 Mia

-- The list --
103 Ellie
102 Alice
105 Chloe
101 Mia
```

Expected output

Extra Task2:

1. Fill the list with the following students using **AddLast**.

   101 Mia

   102 Alice

   103 Ellie

   104 Ruby

2. Display the list using **DisplayList**.
3. Remove student with id =103 using **DeleteNode**.
4. Display the list using **DisplayList**.
5. Display the first Student using **First**.
6. Display the last Student using **Last**.
7. Delete last student using **RemoveLast**.
8. Check if there is a student with ID 109? Using **Find**.

```
-- The list --
101 Mia
102 Alice
103 Ellie
104 Ruby

Delete Student 103:
-- The list --
101 Mia
102 Alice
104 Ruby

First Student is: 101 Mia
Last Student is: 104 Ruby

Delete Last Student:
-- The list --
101 Mia
102 Alice

Is there a student with ID 109?
false
```

Expected output