Data Structure and Algorithm Practicum
Linked List

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1.1 Learning Objective

After learning this practicum, students will be able to:

1. Create a linked list data structure
2. Create a program that implements linked list
3. Differentiate the problems that can be solved with linked list

1.2 Lab Activities 1

In this practicum, we will implement how to create single linked list with nodes data representation, accessing the linked list, and adding the data.

1.2.1 Steps

1. Create a new package named **week11**

2. Add these following classes:

   (a) Node.java

   (b) SingleLinkedList.java

   (c) SLLMain.java

3. Create Node class

```java
package labActivities;

public class Node {
    int data;
    Node next;

    public Node(int data, Node next) {
        this.data = data;
        this.next = next;
    }
}
```

4. Add these following attributes in class **SingleLinkedList**

```java
public class SingleLinkedList {
    Node head;
    Node tail;
}
```

5. For the next step, we will implement methods that are exist in **SingleLinkedList**

```
public class SingleLinkedList {
    Node head;
    Node tail;
}
```

6. Add method isEmpty()

```
public boolean isEmpty() {
    return head == null;
}
```

7. Implement this method to display the data with traverse process

```
public void print() {
    if (!isEmpty()) {
        Node tmp = head;
        System.out.print("Linked list content: \t");
        while (tmp != null) {
            System.out.print(tmp.data + "\t");
            tmp = tmp.next;
        }
        System.out.println("");
    } else {
        System.out.println("Linked list is empty");
    }
}
```

8. Implement method **addFirst()**

```
public void addFirst(int input) {
    Node ndInput = new Node(input, null);
    if (isEmpty()) {
        head = ndInput;
        tail = ndInput;
    } else {
        ndInput.next = head;
        head = ndInput;
    }
}
```

9. Implement method **addLast()**

```
public void addLast(int input) {
    Node ndInput = new Node(input, null);
    if (isEmpty()) {
        head = ndInput;
        tail = ndInput;
    } else {
        tail.next = ndInput;
        tail = ndInput;
    }
}
```

10. Implement method **insertAfter()**, to insert a node that stores data that were inputted by the user after data **key**

```
public void insertAfter(int key, int input) {
    Node ndInput = new Node(input, null);
    Node temp = head;
    do {
        if (temp.data == key) {
            ndInput.next = temp.next;
            temp.next = ndInput;
            if (ndInput.next == null) tail = ndInput;
            break;
        }
        temp = temp.next;
    } while (temp != null);
}
```

11. Add these following codes to add a node based on defined index

```
public void insertAt(int index, int input) {
    if (index < 0) {
        System.out.println("Wrong index");
    } else if (index == 0) {
        addFirst(input);
    } else {
        Node temp = head;
        for (int i = 0; i < index - 1; i++) {
            temp = temp.next;
        }
        temp.next = new Node(input, temp.next);
        if (temp.next.next == null) tail = temp.next;
    }
}
```

12. In class **SLLMain**, create main function and instantiate a new object from **SingleLinkedList** class

```
public class SLLMain {
    public static void main(String[] args) {
        SingleLinkedList singLL = new SingleLinkedList();
    }
}
```

13. Add methods for inserting data, as well as displaying the data for each insert process so that we can track the changes

```
singLL.print();
singLL.addFirst(890);
singLL.print();
singLL.addLast(760);
singLL.print();
singLL.addFirst(700);
singLL.print();
singLL.insertAfter(700, 999);
singLL.print();
singLL.insertAt(3, 833);
singLL.print();
```

1.2.2 Result

```
PS D:\Kuliah\Smt 2\Algoritma dan Struktur Data\Praktikum\Week
 ↪  11\Linked List>  & 'C:\Program
 ↪  Files\Java\jdk-18.0.2.1\bin\java.exe'
 ↪  '-XX:+ShowCodeDetailsInExceptionMessages' '-cp' 'D:\Kuliah\Smt
 ↪  2\Algoritma dan Struktur Data\Praktikum\Week 11\Linked List\bin'
 ↪  'labActivities.SLLMain'
Linked list is empty
Linked list content:    890
Linked list content:    890     760
Linked list content:    700     890     760
Linked list content:    700     999     890     760
Linked list content:    700     999     890     833     760
```

1.2.3 Question

1. Why the output of the program in first line is “Linked list is empty”?

2. Please explain the usage of these following codes in:

```
ndInput.next = temp.next;
temp.next = ndInput;
```

3. In **SingleLinkedList**, what is the usage of this following code in **insertAt**?

```
if (temp.next.next == null) tail =  temp.next;
```

1.3 Lab Activities 2

In this practicum, we will try to learn and implement how to access node elements, get index, and node removal in a Single Linked List

1.3.1 Steps

1. Implement methods to access data and index in linked list

2. Add methods to get data based on certain index from class **SingleLinkedList**

```
public int getData(int index) {
    Node temp = head;
    for (int i = 0; i < index; i++) {
        temp = temp.next;
    }
    return temp.data;
}
```

3. Implement method **indexOf**

```
public int indexOf(int key) {
    Node temp = head;
    int index = 0;
    while (temp != null && temp.data != key) {
        temp = temp.next;
        index++;
    }

    if (temp == null) {
        return -1;
    } else {
        return index;
    }
}
```

4. Add method **removeFirst()** in class **SingleLinkedList**

```
public void removeFirst() {
    if (isEmpty()) {
        System.out.println("Linked list is empty. Can not remove
         ↪  data");
    } else if (head == tail) {
        head = tail = null;
    } else {
        head = head.next;
    }
}
```

5. Add this method to remove data that is in the last of the list from class **SingleLinkedList**

```
public void removeLast() {
    if (isEmpty()) {
        System.out.println("Linked list is empty. Can not remove
         ↪  data");
    } else if (head == tail) {
        head = tail = null;
    } else {
        Node temp = head;
        while (temp.next != tail) {
            temp = temp.next;
        }
        temp.next = null;
        tail = temp;
    }
}
```

6. Next, we will implement method **remove()**

```
public void remove(int key) {
    if (isEmpty()) {
        System.out.println("Linked list is empty. Can not remove
         ↪  data");
    } else {
        Node temp = head;
        while (temp != null) {
            if (temp.data == key && temp == head) {
                this.removeFirst();
                break;
            } else if (temp.next.data == key) {
                temp.next = temp.next.next;
                if (temp.next == null) {
                    tail = temp;
                }
                break;
            }
            temp = temp.next;
        }
    }
}
```

7. Create a method to remove a node based on defined index

```
public void removeAt(int index) {
    if (index == 0) {
        removeFirst();
    } else {
        Node temp = head;
        for (int i = 0; i < index; i++) {
            temp = temp.next;
        }
        temp.next = temp.next.next;
        if (temp.next == null) {
            tail = temp;
        }
    }
}
```

8. Next, we will try to access and remove data in main method in class **SLLMain** by adding these codes

```
System.out.println("Data in the 1st index : " +
 ↪  singLL.getData(1));
System.out.println("Data 3 is in index : " +
 ↪  singLL.indexOf(760));
singLL.remove(999);
singLL.print();
singLL.removeAt(0);
singLL.print();
singLL.removeFirst();
singLL.print();
singLL.removeLast();
singLL.print();
```

9. Method **SLLMain** becomes like this:

```
public class SLLMain {
    public static void main(String[] args) {
        SingleLinkedList singLL = new SingleLinkedList();

        singLL.print();
        singLL.addFirst(890);
        singLL.print();
        singLL.addLast(760);
        singLL.print();
        singLL.addFirst(700);
        singLL.print();
        singLL.insertAfter(700, 999);
        singLL.print();
        singLL.insertAt(3, 833);
        singLL.print();

        System.out.println("Data in the 1st index : " +
        ↪   singLL.getData(1));
        System.out.println("Data 3 is in index : " +
        ↪   singLL.indexOf(760));
        singLL.remove(999);
        singLL.print();
        singLL.removeAt(0);
        singLL.print();
        singLL.removeFirst();
        singLL.print();
        singLL.removeLast();
        singLL.print();
    }
}
```

10. Execute the class **SLLMain**

1.3.2 Result

```
PS D:\Kuliah\Smt 2\Algoritma dan Struktur Data\Praktikum\Week
↪   11\Linked List>  d:; cd 'd:\Kuliah\Smt 2\Algoritma dan Struktur
↪   Data\Praktikum\Week 11\Linked List'; & 'C:\Program
↪   Files\Java\jdk-18.0.2.1\bin\java.exe'
↪   '-XX:+ShowCodeDetailsInExceptionMessages' '-cp' 'D:\Kuliah\Smt
↪   2\Algoritma dan Struktur Data\Praktikum\Week 11\Linked List\bin'
↪   'labActivities.SLLMain'
Linked list is empty
Linked list content:    890
Linked list content:    890     760
Linked list content:    700     890     760
Linked list content:    700     999     890     760
Linked list content:    700     999     890     833     760
Data in the 1st index : 999
Data 3 is in index : 4
Linked list content:    700     890     833     760
Linked list content:    890     833     760
Linked list content:    833     760
Linked list content:    833
```

1.3.3 Question

1. Why we use **break** keyword in remove function? Please explain

2. Please explain why we implement these following codes in method remove

   ```
   else if (temp.next.data == key) {
       temp.next = temp.next.next;
   }
   ```

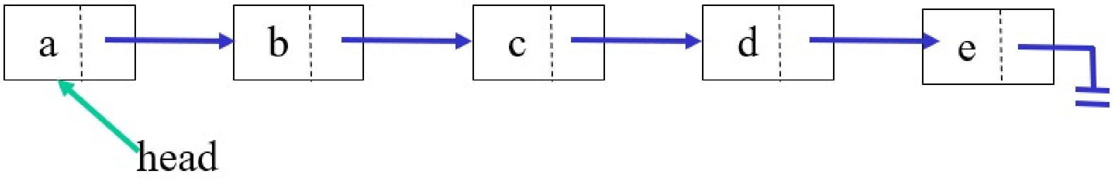
3. What are the outputs of method indexOf? Please explain each of the output!

1.4 Assignments

1. Create a method **insertBefore()** to add node before the desired keyword

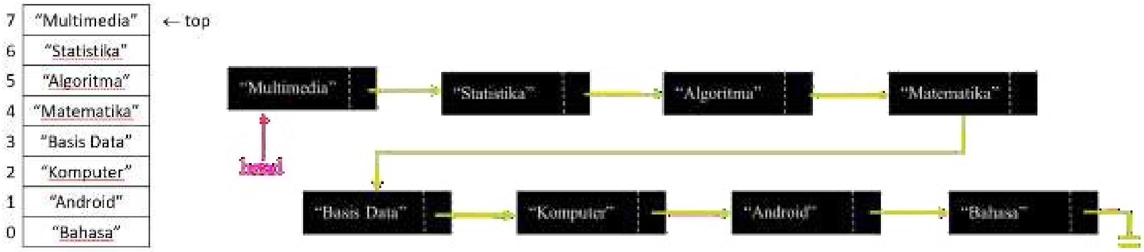
   ```
   public void insertBefore(int key, int input) {
       Node ndInput = new Node(input, null);
       Node temp = head;
       do {
           if (temp.next.data == key) {
               ndInput.next = temp.next;
               temp.next = ndInput;
               if (temp.next == null) temp = head = ndInput;
               break;
           }
           temp = temp.next;
       } while (temp != null);
   }
   ```

2. Implement the linked list from this following image. You may use **4** method of adding data we've learnt



```
singLL.addFirst("a");
singLL.addLast("e");
singLL.insertAt(1, "b")
singLL.insertAfter("b", "c");
singLL.insertAfter("c", "d");
singLL.print();
```

3. Create this following **Stack** implementation using Linked List implementation



7	"Multimedia"	← top
6	"Statistika"	
5	"Algoritma"	
4	"Matematika"	
3	"Basis Data"	
2	"Komputer"	
1	"Android"	
0	"Bahasa"	

4. Create a program that helps bank customer using linked list with data are as follows: Name,address, and customerAccountNumber

5. Implement **Queue** in previous number with **linked list** concept