GTU Department of Computer Engineering
CSE 222/505 - Spring 2023
Homework #03 Report

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Time Complexity Analysis (Worst Case)

	Simple Arrays (hw1)	ArrayList (hw3)	LinkedList (hw3)	LDLinkedList (hw3)
Add element	O(n)	O(n)	O(1)	O(n)

Description: In worst case scenarios (O(n)) we need to resize arrays. But LinkedList structure takes O(1) time. This is because adding elements to the end of a linked list can be done in constant time with 'tail' referance.
(*for hw1 since we don't reach end of the array, worst/best case time complexity is O(1).)

Remove element	–	O(n)	O(n)	O(n)

Description: In the first homework I didn't use remove functionality. Other functions' time complexity is O(n) in worst case scenario (removing last element).

Search element	O(n)	O(n)	O(n)	O(n)

Description: It takes O(n) time in worst case (searching last element of the list) for all structures.

follow()	O(n)	O(n+m)	O(1)	O(n+m)

Description: LinkedList structure takes O(1) time. This is because adding elements to the end of a linked list can be done in constant time with 'tail' referance. For ArrayList and LDLinkedList it takes O(n+m) time and not O(n) because we add new account to both account's follower and following lists. (*for hw1 since we don't reach end of the array, worst/best case time complexity is O(1).)

block()	O(n)	O(n+m)	O(n+m)	O(n+m)

Description: For ArrayList, LinkedList and LDLinkedList it takes O(n+m) time and not O(n) because we remove accounts from both account's follower and following lists. (*for hw1 I didn't use remove function and just added to blocked accounts list, worst/best case time complexity is O(1).)

unfollow()	–	O(n+m)	O(n+m)	O(n+m)

Description: It takes O(n+m) time in worst case for all structures. They call contains and remove functions where n and m are the followers and followings number of both accounts.

unblock()	–	O(n)	O(n)	O(n)

Description: In all worst case scenarios (O(n)) we just call remove and contains fucntions for same list (n elements)..

comment / like()	O(n)	O(n)	O(1)	O(n)

Description: LinkedList structure takes O(1) time. This is because adding elements to the end of a linked list can be done in constant time with 'tail' referance. For ArrayList and LDLinkedList it takes O(n) time. (*for hw1 since we don't reach end of the array, worst/best case time complexity is O(1).)

uncomment / unlike()	–	O(n)	O(n)	O(n)

Description: For ArrayList, LinkedList and LDLinkedList, comment and like functions call remove and contains functions for same list (n elements).

Experimental Running Time Analysis

 Since we didn't reach end of the arrays in homework1, it takes O(1) time in many cases while other structures takes linear time. In the first scenarios, since the operations are not very complex, the times are approximately the same on the basis of seconds, but in the third scenario, the constant and linear time complexity difference in simple arrays and other structures can be measured. It takes less time for simple arrays to do adding operations unless we didn't reach the end.

*values are given in seconds.

Implementation Type	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Basic Array Structure (HW1)	0.14	0.18	0.18	Not available
Array List Structure (a)	0.13	0.19	0.22	0.23
Linked List Structure (b)	0.14	0.18	0.20	0.23
LD Linked List Structure (c)	0.14	0.19	0.20	0.22

Problem Solution Approach for LDLinkedList

- The LDLinkedList class provides a Java implementation of a linked list structure that allows for lazy deletion. It includes methods for adding, getting, and removing elements from the list. The class is designed to be efficient and to avoid unnecessary memory allocations and deallocations.

- The LDLinkedList class extends the AbstractList class in the Java Collections Framework and implements the List interface. It includes fields for the size of the list, a reference to the head node, and a count of the number of nodes that have been marked as "lazily deleted". It also includes an inner class for nodes, which stores data, a reference to the next node, and a boolean indicating whether the node has been marked as "lazily deleted".

- The LDLinkedList class provides implementations of several methods from the List interface and the AbstractList class, including add, size, and get. The add method adds a new node to the end of the list, updating the last node's reference and the size field. The size method returns the current size of the list. The get method returns the data at a specified index in the list. It a nodes is markes as deleted before, it increases index by one and so it pass the deleted node even if it is not deleted physically yet.

- In addition to these basic methods, the LDLinkedList class provides a contains method and a remove method that take an Object as a parameter instead of an index. The contains method checks whether the list contains the specified element by iterating through the list and checking each non-lazily deleted node's data. The remove method checks whether the list contains the specified element by iterating through the list and looking for a non-lazily deleted node whose data equals the specified object. If such a node is found, it is marked as "lazily deleted" and the count of lazily deleted nodes is incremented. If the count reaches 2, the remove method calls a private helper method to physically remove the lazily deleted nodes from the list.

- The 'delete' method iterates through the list and if 'isDeleted' variable is true removes these nodes physically. Then equalize 'deletedCount' to 0 again.

TestClass1-2-3 Running Command and Results

```
**********************************
           SCENARIO 1
**********************************

Step 1... Creating accounts...
An account with username gizemsungu has been created...
An account with username sibelgulmez has been created...
An account with username gokhankaya has been created...

Step 2... Logging into sibelgulmez's account...

Step 3...
Sharing a post...
Sharing a post...

Step 4...
Following gizemsungu's account...
Following gokhankaya's account...

Step 5... Logging out from sibelgulmez's account...

Step 6... Logging into gokhankaya's account...

Step 7... Viewing sibelgulmez's profile...
--------------------------
User ID: 2
Username: sibelgulmez
Location: bursa
Birth Date: 04.01.1995
sibelgulmez is following 2 account(s) and has 0 followers.
sibelgulmez is folowing: gizemsungu gokhankaya
sibelgulmez has 2 post(s).
--------------------------

Step 8... Viewing sibelgulmez's posts...
--------------------------
(Post ID: 1) sibelgulmez: I like Java.
(Post ID: 2) sibelgulmez: Java the coffee...
--------------------------

Step 9...
Liking a post . . .

Step 10... Adding a comment on a post . . .

Step 11...
Following sibelgulmez's account...
Following gizemsungu's account...

Step 12... Sending a message to gizemsungu...

Step 13... Logging out from gokhankaya's account...

Step 14... Logging into gizemsungu's account...

Step 15... Checking gizemsungu's outbox...
There is 0 messages in the gizemsungu's outbox!

Step 16... Checking gizemsungu's inbox...
There is 1 messages in the gizemsungu's inbox!

Step 17... Viewing gizemsungu's inbox...
--------------------------
Message ID: 1
From: gokhankaya
To: gizemsungu
Message: This homework is too easy!
--------------------------

Step 18... Viewing sibelgulmez's profile...
--------------------------
User ID: 2
Username: sibelgulmez
Location: bursa
Birth Date: 04.01.1995
sibelgulmez is following 2 account(s) and has 1 followers.
sibelgulmez is folowing: gizemsungu gokhankaya
sibelgulmez's followers: gokhankaya
sibelgulmez has 2 post(s).
--------------------------

Step 19... Viewing sibelgulmez's posts...
--------------------------
(Post ID: 1) sibelgulmez: I like Java.
(Post ID: 2) sibelgulmez: Java the coffee...
--------------------------

Step 20... Viewing sibelgulmez's post interactions...
--------------------------
(PostID: 1): I like Java.
The post was liked by the following account(s): gokhankaya
The post has 1 comment(s)...
Comment 1: gokhankaya said "Me too!"
--------------------------
(PostID: 2): Java the coffee...
The post has no likes.
The post has 0 comment(s)...
--------------------------

Step 21...
Liking a post . . .
Liking a post . . .
```

```
Step 22.. Viewing sibelgulmez's post interactions...
--------------------------
(PostID: 1): I like Java.
The post was liked by the following account(s): gokhankaya gizemsungu
The post has 1 comment(s)...
Comment 1: gokhankaya said "Me too!"
--------------------------
(PostID: 2): Java the coffee...
The post was liked by the following account(s): gizemsungu
The post has 0 comment(s)...
--------------------------


**********************************************
                SCENARIO 2
**********************************************

Step 23...
Sharing a post...
Sharing a post...

Step 24... Logging out from gizemsungu's account...

Step 25... Logging into sibelgulmez's account...

Step 26... Viewing gizemsungu's profile...
--------------------------
User ID: 1
Username: gizemsungu
Location: istanbul
Birth Date: 19.06.1992
gizemsungu is following 0 account(s) and has 2 followers.
gizemsungu follows nobody.
gizemsungu's followers: sibelgulmez gokhankaya
gizemsungu has 2 post(s).
--------------------------

Step 27...
Liking a post . . .

Step 28... Logging out from sibelgulmez's account...

Step 29... Logging into gokhankaya's account...

Step 30... Viewing gizemsungu's profile...
--------------------------
User ID: 1
Username: gizemsungu
Location: istanbul
Birth Date: 19.06.1992
gizemsungu is following 0 account(s) and has 2 followers.
gizemsungu follows nobody.
gizemsungu's followers: sibelgulmez gokhankaya
gizemsungu has 2 post(s).
--------------------------

Step 31... Adding a comment on a post . . .

Step 32... Sending a message to gizemsungu...

Step 33... Logging out from gokhankaya's account...

Step 34... Logging into gizemsungu's account...

Step 35... Viewing gizemsungu's profile...
--------------------------
User ID: 1
Username: gizemsungu
Location: istanbul
Birth Date: 19.06.1992
gizemsungu is following 0 account(s) and has 2 followers.
gizemsungu follows nobody.
gizemsungu's followers: sibelgulmez gokhankaya
gizemsungu has 2 post(s).
--------------------------

Step 36... Viewing gizemsungu's inbox...
--------------------------
Message ID: 1
From: gokhankaya
To: gizemsungu
Message: This homework is too easy!
--------------------------
Message ID: 2
From: gokhankaya
To: gizemsungu
Message: Hello!
--------------------------


**********************************************
                SCENARIO 3
**********************************************


Step 37... Blocking sibelgulmez's account...

Step 38... Logging out from gizemsungu's account...

Step 39... Logging into sibelgulmez's account...

Step 40... Sending a message to gizemsungu...
ERROR: You can't send message to gizemsungu, you are BLOCKED!!!
```

TestClass4
Running Command and Results

Compiling commands:

cd package1
javac *.java
cd..

Running commands:

java package1.TestClass4

```
C:\Users\Administrator\Desktop\OKUL\cse222\homework3>java package3.TestClass4

****************************************
                SCENARIO 4
****************************************
An account with username gizemsungu has been created...
An account with username sibelgulmez has been created...
An account with username gokhankaya has been created...
An account with username account4 has been created...
An account with username account5 has been created...
An account with username account6 has been created...
An account with username account7 has been created...
An account with username account8 has been created...
An account with username account9 has been created...
An account with username account10 has been created...

****************************************
            TESTING FOLLOW - UNFOLLOW
****************************************


Logging into gokhankaya's account...

Following gokhankaya's account...
ERROR: You can't follow yourself!

Following account6's account...
Following account7's account...
Following account8's account...
Following account9's account...
Following account10's account...
Following gizemsungu's account...
Viewing gokhankaya's profile...
--------------------------
User ID: 3
Username: gokhankaya
Location: yalova
Birth Date: 24.11.1985
gokhankaya is following 6 account(s) and has 0 followers.
gokhankaya is folowing: account6 account7 account8 account9 account10 gizemsungu
gokhankaya has no followers.
gokhankaya has 0 post(s).
--------------------------

Unfollowing account8's account...
Viewing gokhankaya's profile...
--------------------------
User ID: 3
Username: gokhankaya
Location: yalova
Birth Date: 24.11.1985
gokhankaya is following 5 account(s) and has 0 followers.
gokhankaya is folowing: account6 account7 account9 account10 gizemsungu
gokhankaya has no followers.
gokhankaya has 0 post(s).
--------------------------

Unfollowing account7's account...
Viewing gokhankaya's profile...
--------------------------
User ID: 3
Username: gokhankaya
Location: yalova
Birth Date: 24.11.1985
gokhankaya is following 4 account(s) and has 0 followers.
gokhankaya is folowing: account6 account9 account10 gizemsungu
gokhankaya has no followers.
gokhankaya has 0 post(s).
--------------------------

Logging out from gokhankaya's account...

****************************************
            TESTING BLOCK - UNBLOCK
****************************************


Logging into gizemsungu's account...

Following gokhankaya's account...
Following sibelgulmez's account...
Following account7's account...
Following account10's account...
Viewing gokhankaya's profile...
--------------------------
User ID: 3
Username: gokhankaya
Location: yalova
Birth Date: 24.11.1985
gokhankaya is following 4 account(s) and has 1 followers.
gokhankaya is folowing: account6 account9 account10 gizemsungu
gokhankaya's followers: gizemsungu
gokhankaya has 0 post(s).
--------------------------

Viewing gizemsungu's profile...
--------------------------
User ID: 1
Username: gizemsungu
Location: istanbul
Birth Date: 19.06.1992
gizemsungu is following 4 account(s) and has 1 followers.
gizemsungu is folowing: gokhankaya sibelgulmez account7 account10
gizemsungu's followers: gokhankaya
gizemsungu has 0 post(s).
--------------------------
Blocking gokhankaya's account...
Blocking sibelgulmez's account...

Viewing gokhankaya's profile...
--------------------------
User ID: 3
Username: gokhankaya
Location: yalova
Birth Date: 24.11.1985
gokhankaya is following 3 account(s) and has 0 followers.
gokhankaya is folowing: account6 account9 account10
gokhankaya has no followers.
gokhankaya has 0 post(s).
--------------------------

Viewing gizemsungu's profile...
--------------------------
User ID: 1
Username: gizemsungu
Location: istanbul
Birth Date: 19.06.1992
gizemsungu is following 2 account(s) and has 0 followers.
gizemsungu is folowing: account7 account10
gizemsungu has no followers.
gizemsungu has 0 post(s).
--------------------------

Logging out from gizemsungu's account...
Logging into gokhankaya's account...

Following gizemsungu's account...
ERROR: You can't follow gizemsungu, you are BLOCKED!!!

Viewing gizemsungu's profile...

ERROR: You can't view gizemsungu's profile', you are BLOCKED!!!

Logging out from gokhankaya's account...
Logging into gizemsungu's account...
Unblocking gokhankaya's account...

Logging out from gizemsungu's account...
Logging into gokhankaya's account...

Following gizemsungu's account...
Viewing gizemsungu's profile...
--------------------------
User ID: 1
Username: gizemsungu
Location: istanbul
Birth Date: 19.06.1992
gizemsungu is following 2 account(s) and has 1 followers.
gizemsungu is folowing: account7 account10
gizemsungu's followers: gokhankaya
gizemsungu has 0 post(s).
--------------------------

Viewing gokhankaya's profile...
--------------------------
```

```
User ID: 3
Username: gokhankaya
Location: yalova
Birth Date: 24.11.1985
gokhankaya is following 4 account(s) and has 0 followers.
gokhankaya is folowing: account6 account9 account10 gizemsungu
gokhankaya has no followers.
gokhankaya has 0 post(s).
--------------------------

Logging out from gokhankaya's account...

************************************************
          TESTING COMMENT - UNCOMMENT
************************************************


Logging into account4's account...

Sharing a post...
Logging out from account4's account...
Logging into sibelgulmez's account...

Liking a post . . .
Adding a comment on a post . . .

Viewing account4's profile...
--------------------------
User ID: 4
Username: account4
Location: ankara
Birth Date: 19.06.1992
account4 is following 0 account(s) and has 0 followers.
account4 follows nobody.
account4 has no followers.
account4 has 1 post(s).
--------------------------
Viewing account4's posts...
--------------------------
(Post ID: 1) account4: Nice day!
--------------------------

Viewing account4's post interactions...
```

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--------------------------
(PostID: 1): Nice day!
The post was liked by the following account(s): sibelgulmez
The post has 1 comment(s)...
Comment 1: sibelgulmez said "Really!"
--------------------------

Unliking a post . . .
Removing a comment on a post . . .

Viewing account4's post interactions...
--------------------------
(PostID: 1): Nice day!
The post has no likes.
The post has 0 comment(s)...
--------------------------

************************************************
            TESTING SHOWING HISTORY
************************************************


Viewing sibelgulmez's history...
--------------------------
You logged in
You liked account4's post id: 1
You commented account4's post id: 1
You viewed account4's profile
You viewed account4's posts...
You viewed account4's interactions
You unliked account4's post id: 1
You uncommented account4's post id: 1
You viewed account4's interactions
--------------------------

Sending a message to account6...
ERROR: You have to follow account6 to send a message...


Following account6's account...
Sending a message to account6...
Viewing sibelgulmez's history...
--------------------------
You logged in
You liked account4's post id: 1
You commented account4's post id: 1
You viewed account4's profile
You viewed account4's posts...
You viewed account4's interactions
You unliked account4's post id: 1
You uncommented account4's post id: 1
You viewed account4's interactions
You viewed your history
You followed account6
You sent a message to account6
--------------------------


Logging out from sibelgulmez's account...
Logging into account6's account...
Checking account6's inbox...
There is 1 messages in the account6's inbox!
Checking account6's outbox...
There is 0 messages in the account6's outbox!
Viewing account6's inbox...
--------------------------
Message ID: 1
From: sibelgulmez
To: account6
Message: what's up
--------------------------

Following account4's account...
Viewing account5's post interactions...
No posts found!
```