Sorted and Doubly Linked Lists

University of Massachusetts Amherst
ECE 242 – Data Structures and Algorithms
Lecture 13

Variants of linked lists

- Today:
  - Sorted linked list
  - Doubly linked list
- Variants require changes
  - Sorted linked list: how objects are arranged in list
  - Doubly linked list: list objects themselves

Sorted linked list

- What do we need to change for a sorted linked list?

Insertion in sorted linked list

- Revised insertion operation

```
public void insert(int item) {
      ListObject o = new ListObject(item);
      ListObject previous = first;

      if (first == null) { // list is empty
            first = o;
            return;
      }
      if (first.data >= item) { // item needs to go at first spot of list
            o.next = first;
            first = o;
            return;
      }
      while (previous.next!=null && previous.next.data<item) {
            // traverse until end of list or spot is found
            previous = previous.next;
      }
      if (previous.next==null) { // check if at end of list
            previous.next = o;
            return;
      } else { // implement insertion
            o.next = previous.next;
            previous.next = o;
            return;
      }
}
```

Sorted linked list

- Code:
  - List object: ListObject.java
  - List functionality: SortedLinkedList.java
  - main() method: SortedLinkedListExample.java

Observations

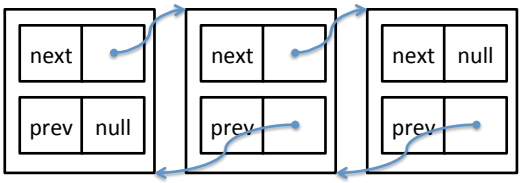
- Insertion in singly linked list is complex
  - Doubly linked list improves problem
- Complexity of operations
  - Unsorted linked list
    - Insertion
    - Removal of specific element
  - Sorted linked list
    - Insertion
    - Removal of specific element
  - Can we use binary search on sorted linked list?

Observations

- Insertion in singly linked list is complex
  - Doubly linked list improves problem
- Complexity of operations
  - Unsorted linked list
    - Insertion: O(1)
    - Removal of specific element: O(n)
  - Sorted linked list
    - Insertion: O(n)
    - Removal of specific element: O(n)
  - Can we use binary search on sorted linked list? Yes but not efficient

Doubly linked list

- Main idea:
  - Have pointer to next and previous element in list



- What do we need to change from linked list?

Doubly linked list

- DoublyListObject has additional pointer

```
public class DoublyListObject {
    public int data;
    public DoublyListObject prev;
    public DoublyListObject next;

    public DoublyListObject(int item) {
        data = item;
        prev = null;
        next = null;
    }
}
```


Doubly linked list

- Code:
  - List object: DoublyListObject.java
  - List functionality: DoublyLinkedList.java
  - main() method: DoublyLinkedListExample.java

Insertion in doubly linked list

```
public class DoublyLinkedList {
    private DoublyListObject first;

    public DoublyLinkedList() {
        first = null;
    }

    public void insertFirst(int item) {









    }
}
```


Insertion in doubly linked list

```
public class DoublyLinkedList {
    private DoublyListObject first;

    public DoublyLinkedList() {
        first = null;
    }

    public void insertFirst(int item) {
        DoublyListObject o = new DoublyListObject(item);

        o.next = first;
        if (first!=null) { // list has elements
            first.prev = o;
        }
        first = o;
    }
}
```

Find and remove element

```
public void findAndDelete(int item) {









}
```


Find and remove element

```
public void findAndDelete(int item) {
    DoublyListObject current = first;

    while (current!=null && current.data!=item) {  // traversal
        current = current.next;
    }
    if (current==null) { // end of list and no match
        return;
    } else {
        if (current.prev!=null) { // not first element
            current.prev.next = current.next;
        } else {  // first element
            first = current.next;
        }
        if (current.next!=null) {  //not last element
            current.next.prev = current.prev;
        }
        return;
    }
}
```

Doubly linked list tradeoff

- Benefits
  - Easier removal of objects
- Drawback
  - Need to manage multiple pointers
- Other variants
  - More complex lists simplify some specific operations
    - E.g., double-ended, doubly linked list

Double-ended doubly linked list

- Code:
  - List object: DoublyListObject.java
  - List functionality: DoublyLinkedDoubleEndedList.java
  - main() method: DoublyLinkedDoubleEndedListExample.java

Next Steps

- Discussions Thursday
- Lecture on Friday