Lecture 3-2. Linked Lists

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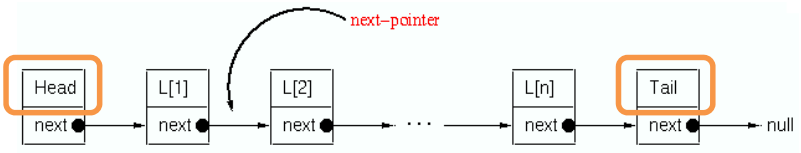
Keywords

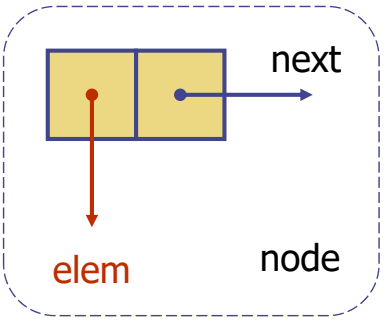
- Linked List
  - A representative type of list
  - Node, Pointer (Link), Head, Tail

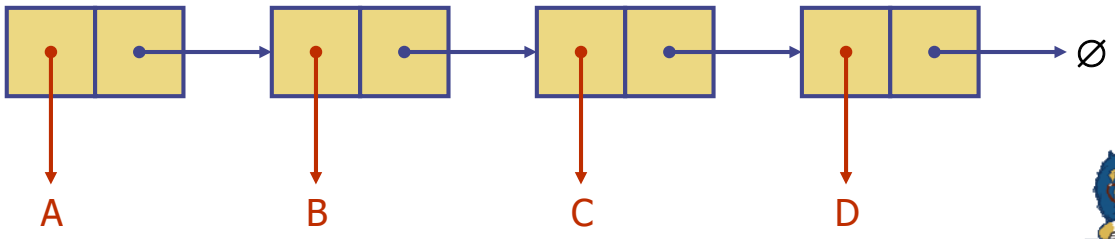


- Singly Linked List
  - Linked List with one directional pointer
- Doubly Linked List
  - Linked List with both directional pointers

Singly Linked List (§3.2)

- A singly linked list is a concrete data structure consisting of a sequence of nodes
- Each node stores
  - element
  - link to the next node





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The Node Class for List Nodes

```
public class Node          {
    // Instance variables:
    private  Object element;
    private  Node next;
    /** Creates a node with null references to its element and next node. */
    public  Node()          {
       this(null,  null);
    }
    /** Creates a node with the given element and next node. */
    public  Node(Object e,  Node n)  {
         element  =  e;
         next  =  n;
    }
    // Accessor methods:
    public  Object getElement()  {
       return  element;
    }
    public  Node getNext()  {
       return  next;
    }
    // Modifier methods:
    public void  setElement(Object newElem)  {
         element  =  newElem;
    }
    public void  setNext(Node newNext)  {
         next  =  newNext;
    }
}
```

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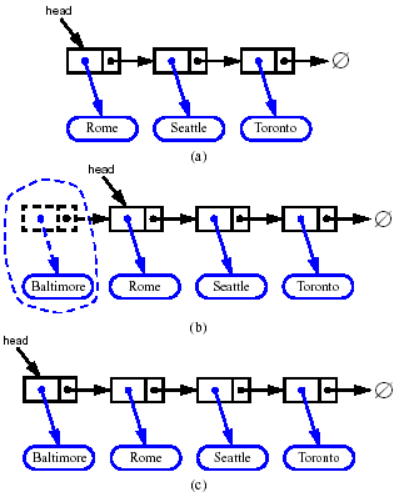
Inserting at the Head

1.

2.

3.

4.



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Inserting at the Tail

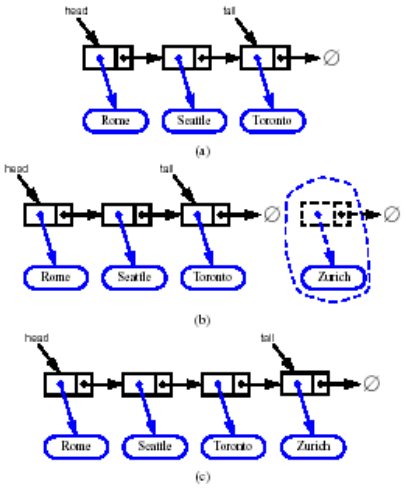
1.

2.

3.

4.

5.



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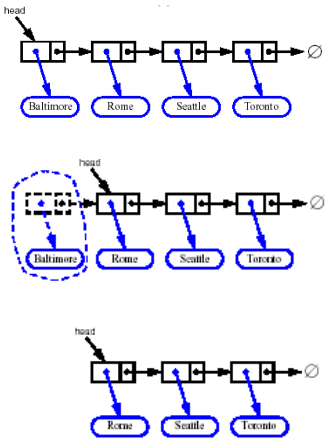
Removing at the Head

1.

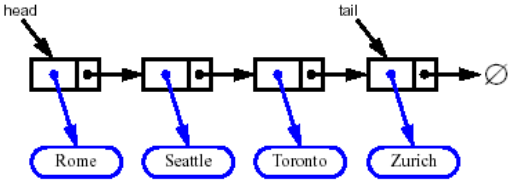
2.



Removing at the Tail

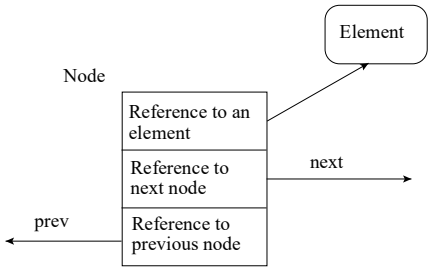
- **Removing at the tail of a singly linked list is not efficient!**
- There is no constant-time way to update the tail to point to the previous node

메모리 사용량도 빅O로 나타내면 링크드 리스트이던 어레이 리스트이든 O(n)가 된다



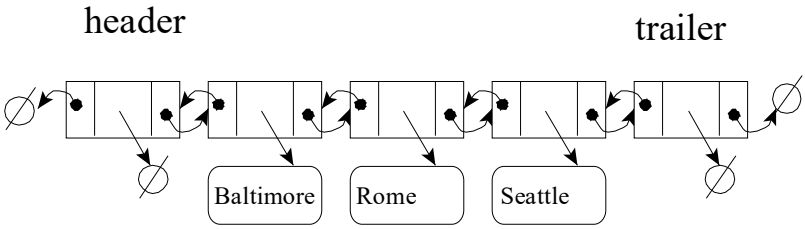
Doubly Linked List (§3.3)

- Recall that the deletion of an element at the tail is not easy because we have to find the node before the tail (the last node) by link hopping.
  - This problem can be easily solved by using the doubly linked list
- A **node** in a doubly linked list
  - A compound object that stores a reference to an element and two references, called **next** and **prev**, to the next and previous nodes, respectively.



Doubly Linked List

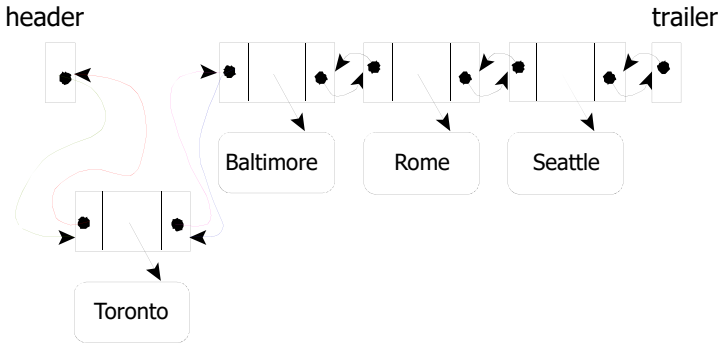
- Header and Trailer Sentinels
  - to simplify programming, a doubly linked list has a header and trailer nodes
  - they are called sentinel nodes which do not store any elements and just indicate both the ends of a list



- Difference from Singly Linked List
  - each node contains two links
  - two extra nodes: header and trailer, which contain no element

Insertion in the Middle of a Doubly Linked List

- Allowing for insertion and removal in the middle of the list
  - insert a new node ***z*** after ***v*** (***w*** is the next node of ***v***)
  1.
  2.
  3.
  4.



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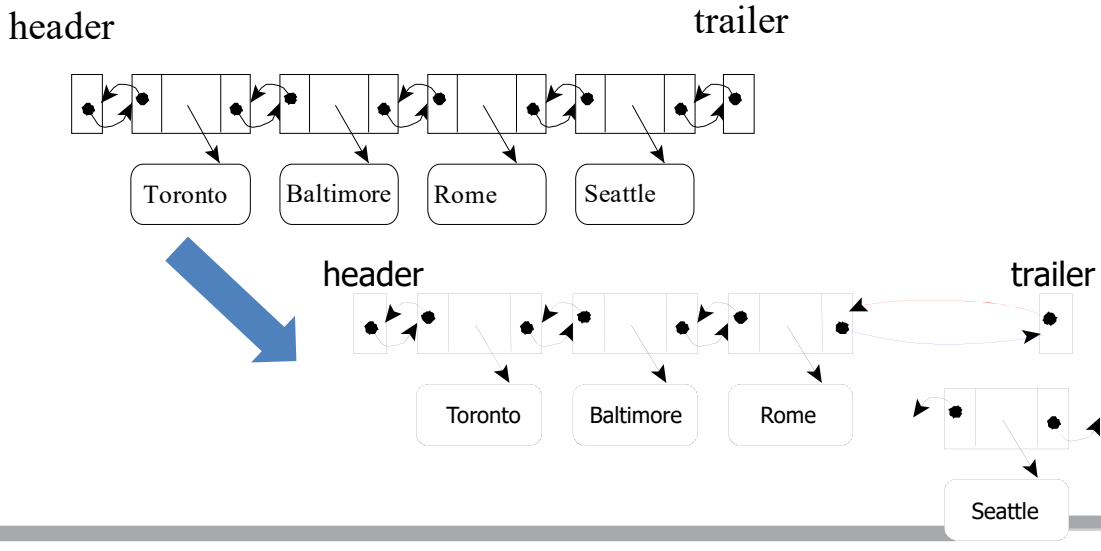
Removal in the Middle of a Doubly Linked List

- Easy to remove a node ***v*** in the middle (even in the end) of a doubly linked list
  - to remove node ***v*** in the list, we simply have nodes, which are ***prev*** and ***next*** of node ***v***, point to each other



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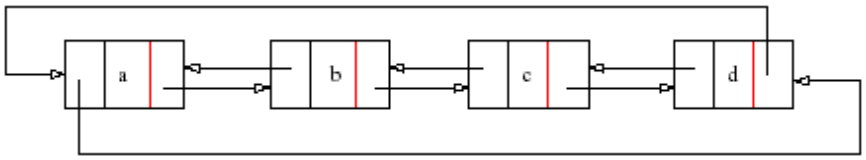
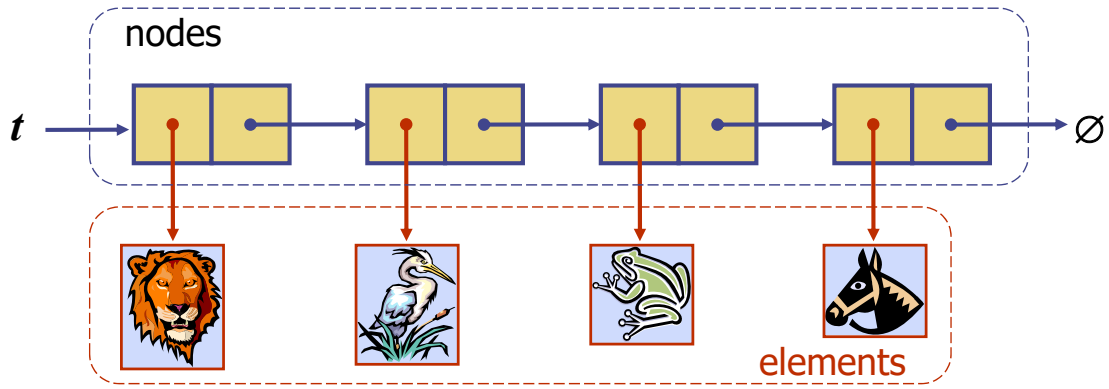
Circularly Linked List (§3.4)

- No Head (First) or Tail (Last) node
- Instead of having the last node's next pointer be **null**, it points back to the first node
  - if we traverse the nodes of a circularly linked list from any node by following next pointers, we will cycle through the nodes
- Cursor
  - marked as a special node which identifies the current position



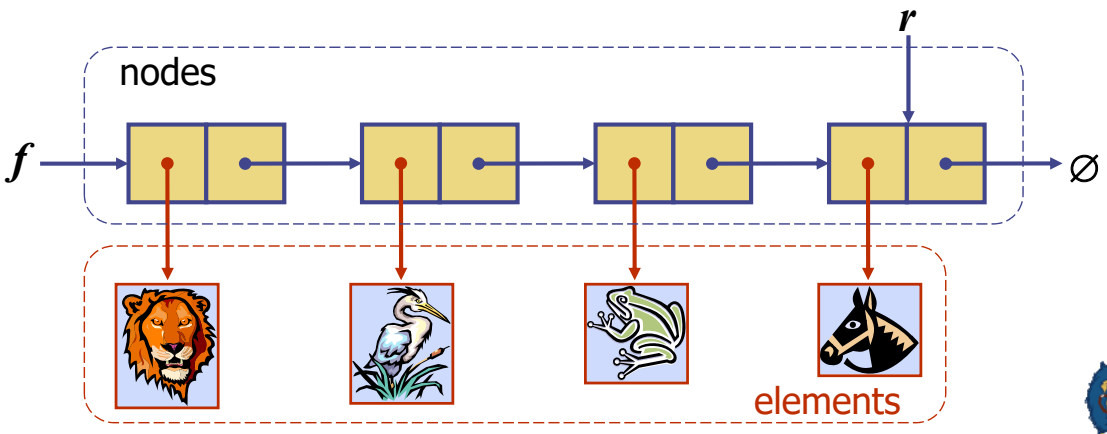
Stack as a Linked List (§ 5.1.3)

- We can implement a stack with a singly linked list
- The top element is stored at the first node of the list
- The space used is ($o(n)$) and each operation of the Stack ADT takes ($o(1)$) time



Queue as a Linked List (§ 5.2.3)

- We can implement a queue with a singly linked list
  - The front element is stored at the first node
  - The rear element is stored at the last node
- The space used is ( ) and each operation of the Queue ADT takes ( ) time



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