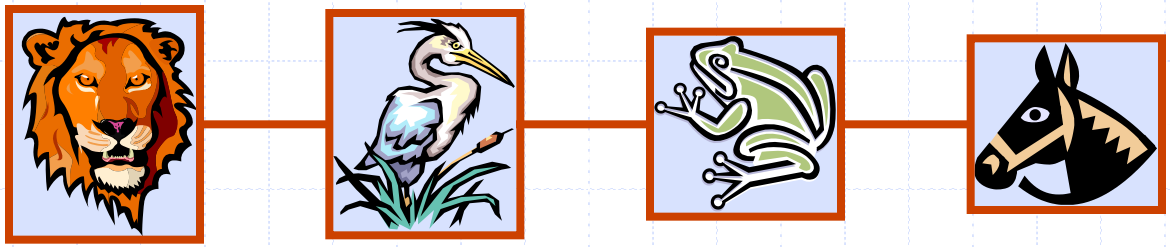
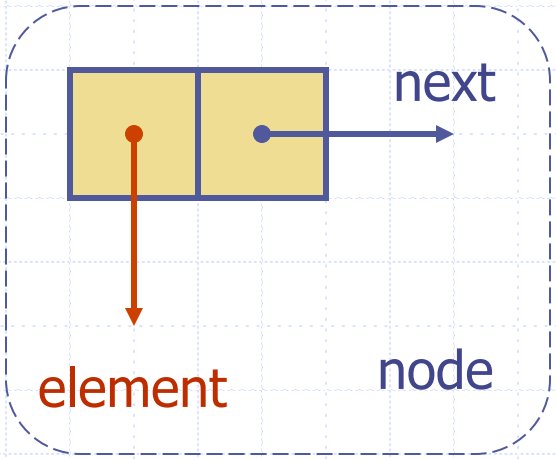
Presentation for use with the textbook Data Structures and Algorithms in Java, 6th edition, by M. T. Goodrich, R. Tamassia, and M. H. Goldwasser, Wiley, 2014

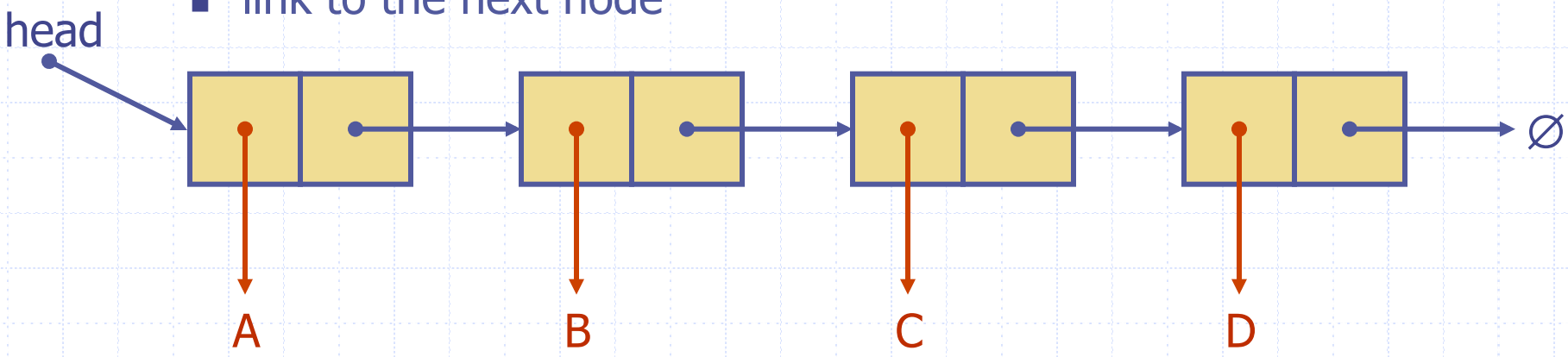
Singly Linked Lists



Singly Linked List

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





A Nested Node Class

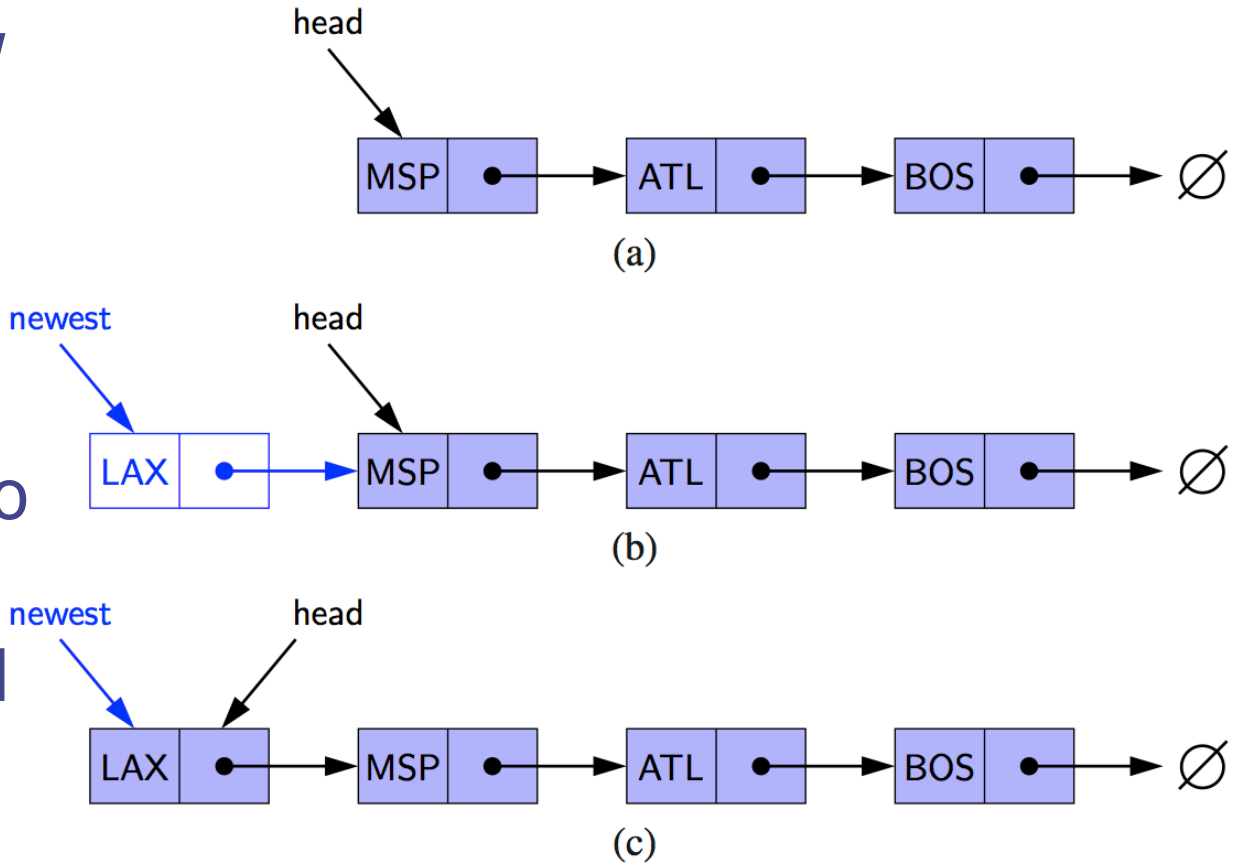
```
1   public class SinglyLinkedList<E> {
2     //---------------- nested Node class ----------------
3     private static class Node<E> {
4       private E element;                  // reference to the element stored at this node
5       private Node<E> next;               // reference to the subsequent node in the list
6       public Node(E e, Node<E> n) {
7         element = e;
8         next = n;
9       }
10      public E getElement( ) { return element; }
11      public Node<E> getNext( ) { return next; }
12      public void setNext(Node<E> n) { next = n; }
13    } //---------- end of nested Node class ----------
      ... rest of SinglyLinkedList class will follow ...
```

Accessor Methods

```
1   public class SinglyLinkedList<E> {
...     (nested Node class goes here)
14    // instance variables of the SinglyLinkedList
15    private Node<E> head = null;          // head node of the list (or null if empty)
16    private Node<E> tail = null;          // last node of the list (or null if empty)
17    private int size = 0;                 // number of nodes in the list
18    public SinglyLinkedList( ) { }        // constructs an initially empty list
19    // access methods
20    public int size( ) { return size; }
21    public boolean isEmpty( ) { return size == 0; }
22    public E first( ) {                   // returns (but does not remove) the first element
23      if (isEmpty( )) return null;
24      return head.getElement( );
25    }
26    public E last( ) {                    // returns (but does not remove) the last element
27      if (isEmpty( )) return null;
28      return tail.getElement( );
29    }
```

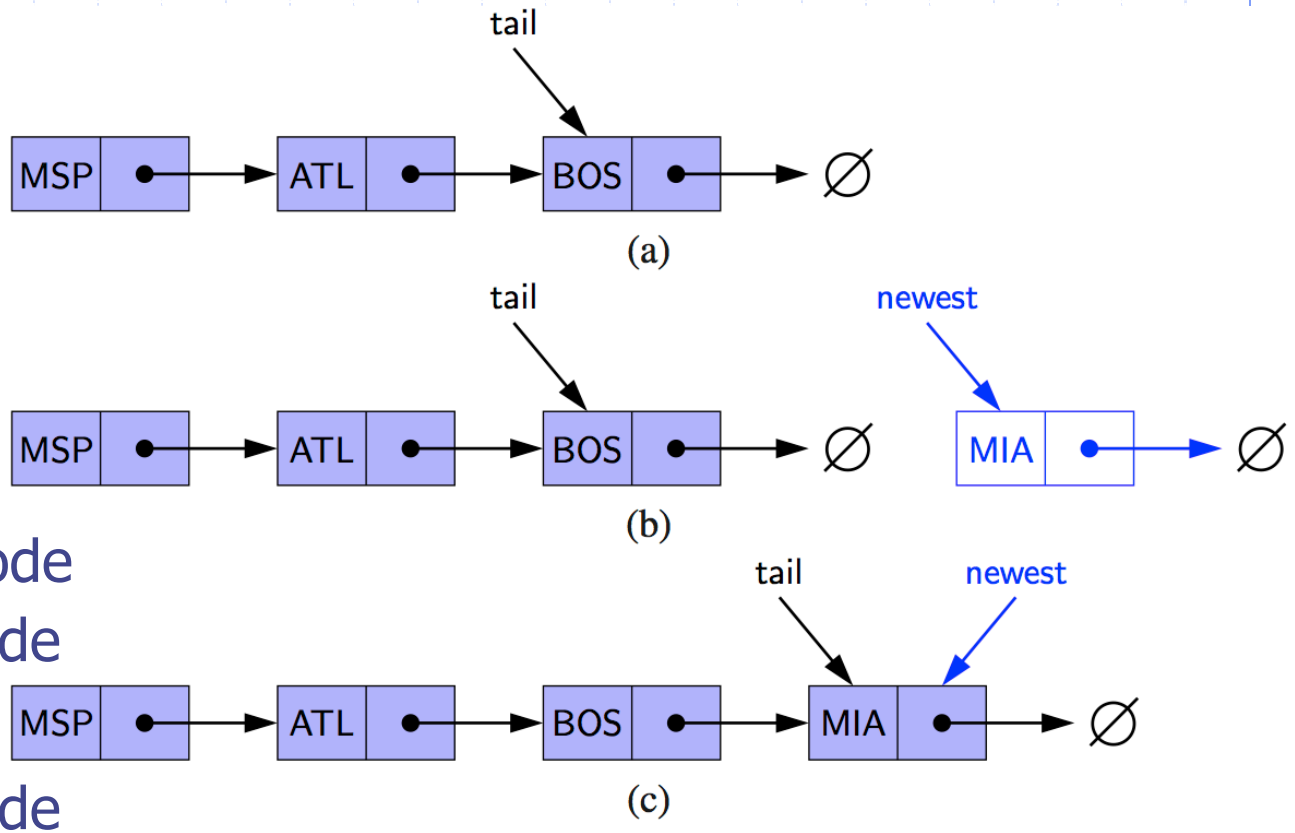
Inserting at the Head

- Allocate new node
- Insert new element
- Have new node point to old head
- Update head to point to new node



Inserting at the Tail

- Allocate a new node
- Insert new element
- Have new node point to null
- Have old last node point to new node
- Update tail to point to new node

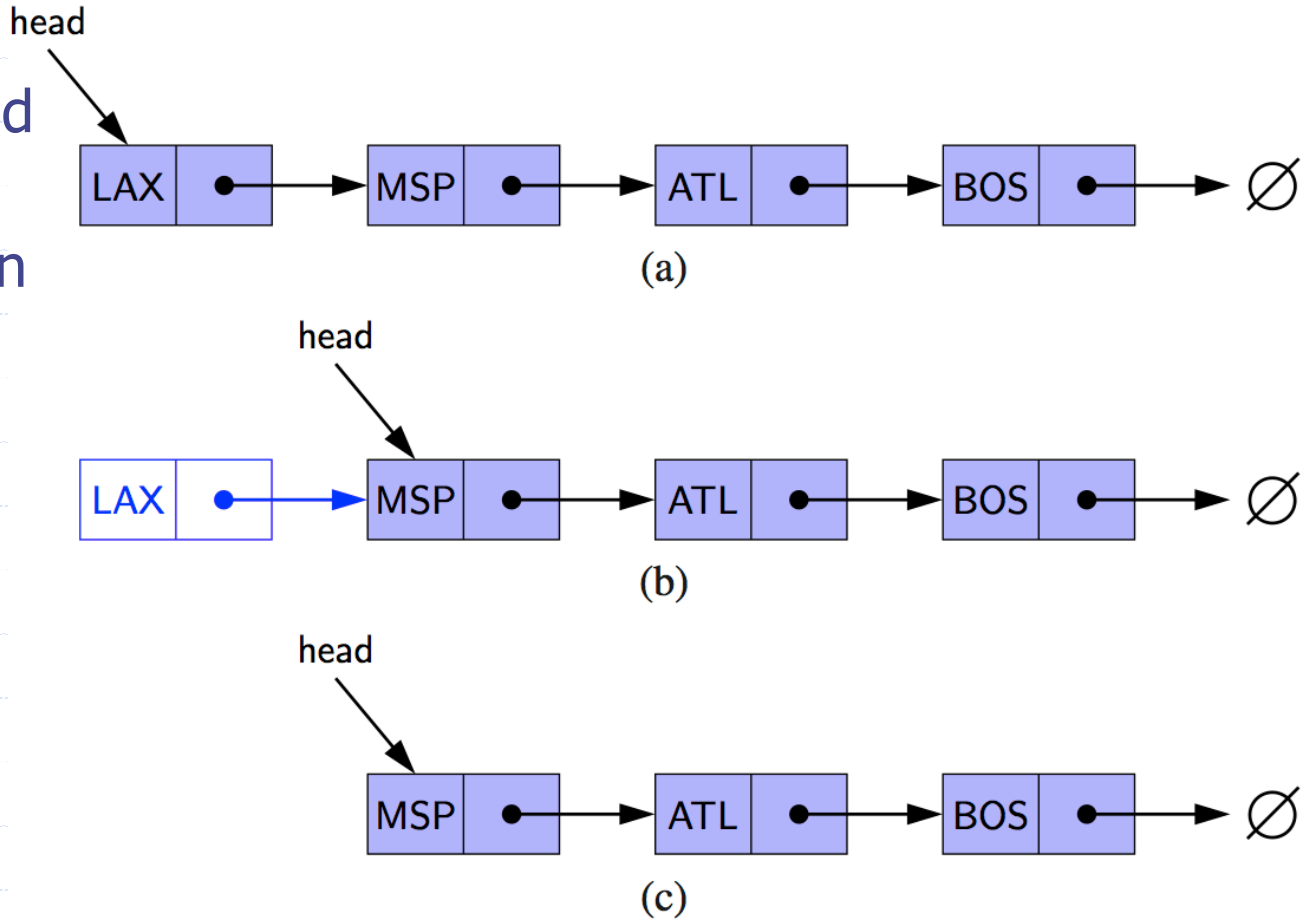


Java Methods

```
31    public void addFirst(E e) {                // adds element e to the front of the list
32      head = new Node<>(e, head);              // create and link a new node
33      if (size == 0)
34        tail = head;                           // special case: new node becomes tail also
35      size++;
36    }
37    public void addLast(E e) {                 // adds element e to the end of the list
38      Node<E> newest = new Node<>(e, null);    // node will eventually be the tail
39      if (isEmpty( ))
40        head = newest;                         // special case: previously empty list
41      else
42        tail.setNext(newest);                  // new node after existing tail
43      tail = newest;                           // new node becomes the tail
44      size++;
45    }
```

Removing at the Head

- Update head to point to next node in the list
- Allow garbage collector to reclaim the former first node



Java Method

```
46    public E removeFirst( ) {                  // removes and returns the first element
47      if (isEmpty( )) return null;             // nothing to remove
48      E answer = head.getElement( );
49      head = head.getNext( );                  // will become null if list had only one node
50      size−−;
51      if (size == 0)
52        tail = null;                           // special case as list is now empty
53      return answer;
54    }
55  }
```

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