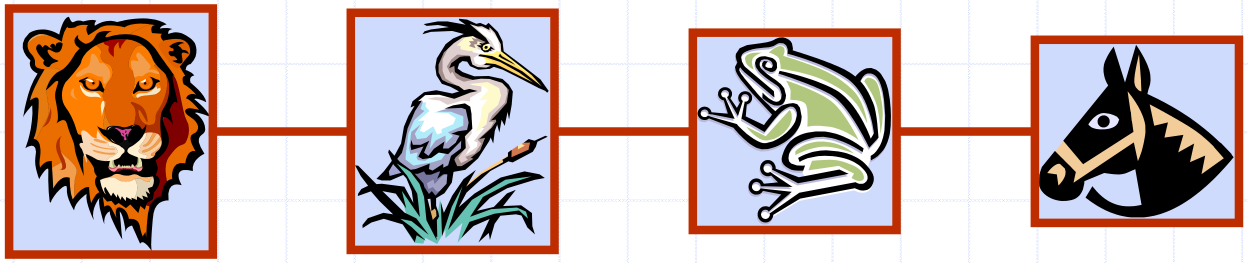
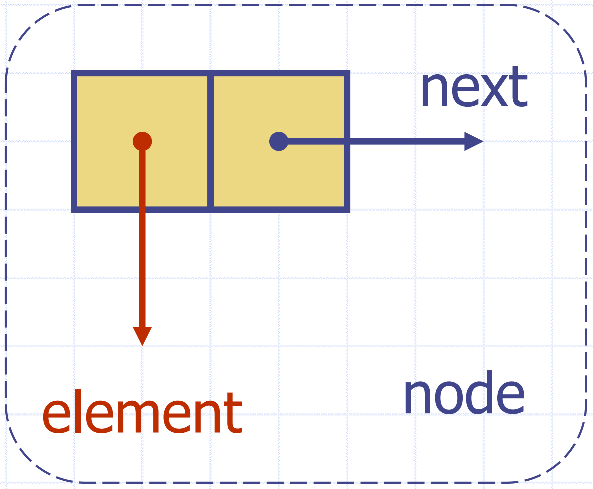
Presentation for use with the textbook Data Structures and Algorithms in Java, 6th edition, by M. T. Goodrich, R. Tamassia, and M. H. Goldwasser, Wiley, 2014

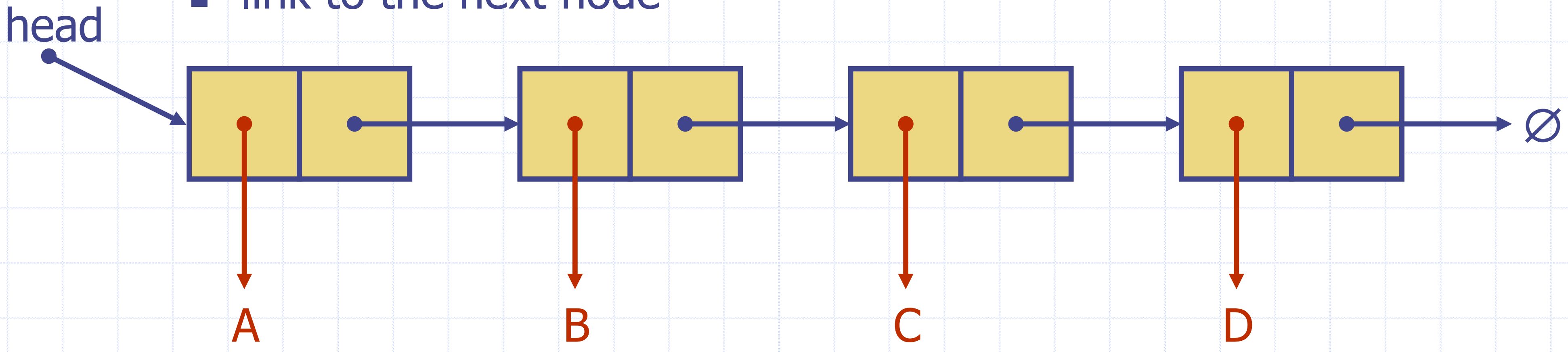
Singly Linked Lists



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

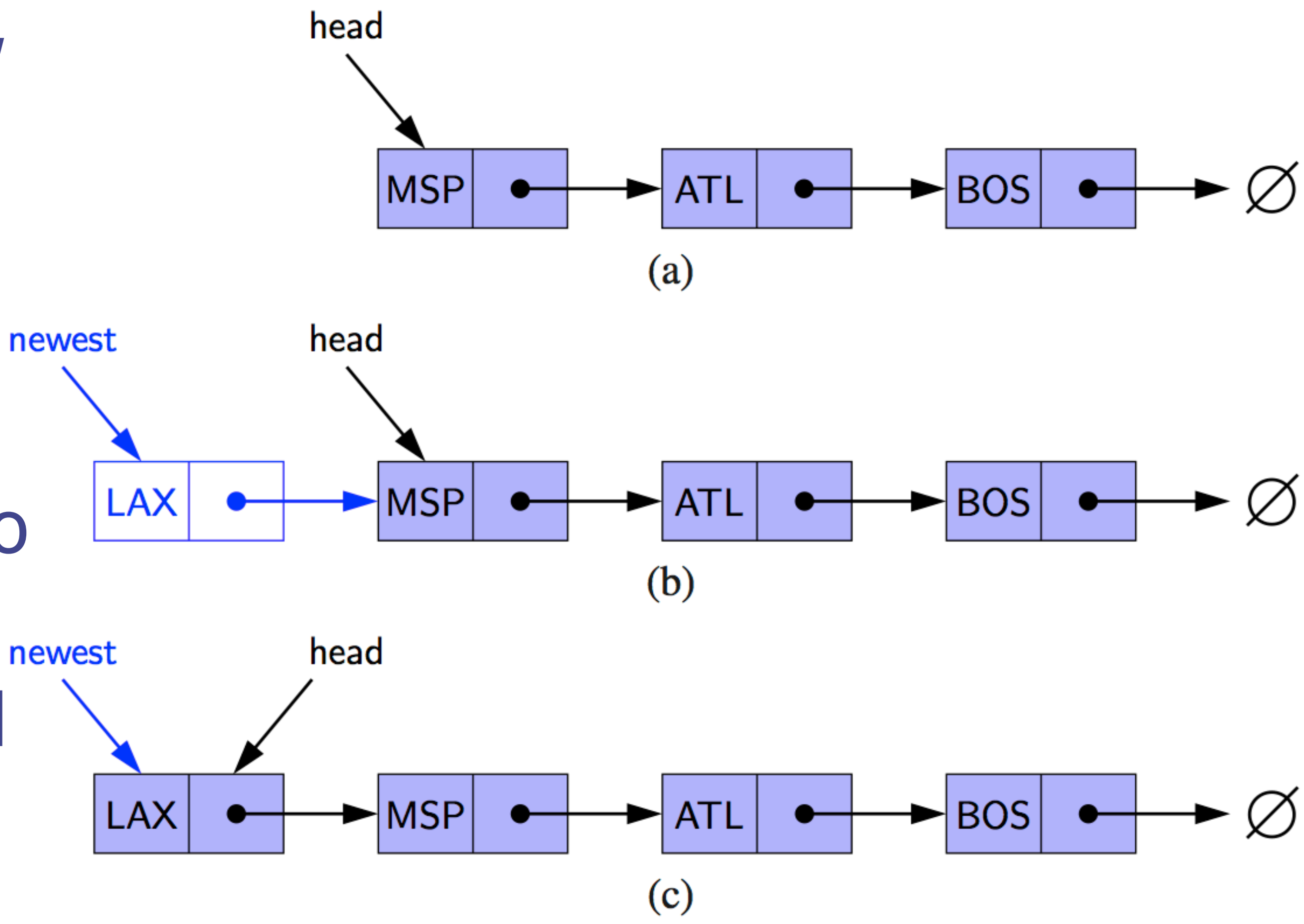
```
public class SinglyLinkedList<E> {
  //---------------- nested Node class ----------------
  private static class Node<E> {
    private E element;                // reference to the element stored at this node
    private Node<E> next;             // reference to the subsequent node in the list
    public Node(E e, Node<E> n) {
      element = e;
      next = n;
    }
    public E getElement( ) { return element; }
    public Node<E> getNext( ) { return next; }
    public void setNext(Node<E> n) { next = n; }
  } //----------- end of nested Node class -----------
  ... rest of SinglyLinkedList class will follow ...
```

Accessor Methods

```
public class SinglyLinkedList<E> {
  (nested Node class goes here)
  // instance variables of the SinglyLinkedList
  private Node<E> head = null;          // head node of the list (or null if empty)
  private Node<E> tail = null;          // last node of the list (or null if empty)
  private int size = 0;                 // number of nodes in the list
  public SinglyLinkedList( ) { }        // constructs an initially empty list
  // access methods
  public int size( ) { return size; }
  public boolean isEmpty( ) { return size == 0; }
  public E first( ) {               // returns (but does not remove) the first element
    if (isEmpty( )) return null;
    return head.getElement( );
  }
  public E last( ) {                // returns (but does not remove) the last element
    if (isEmpty( )) return null;
    return tail.getElement( );
  }
```

Inserting at the Head

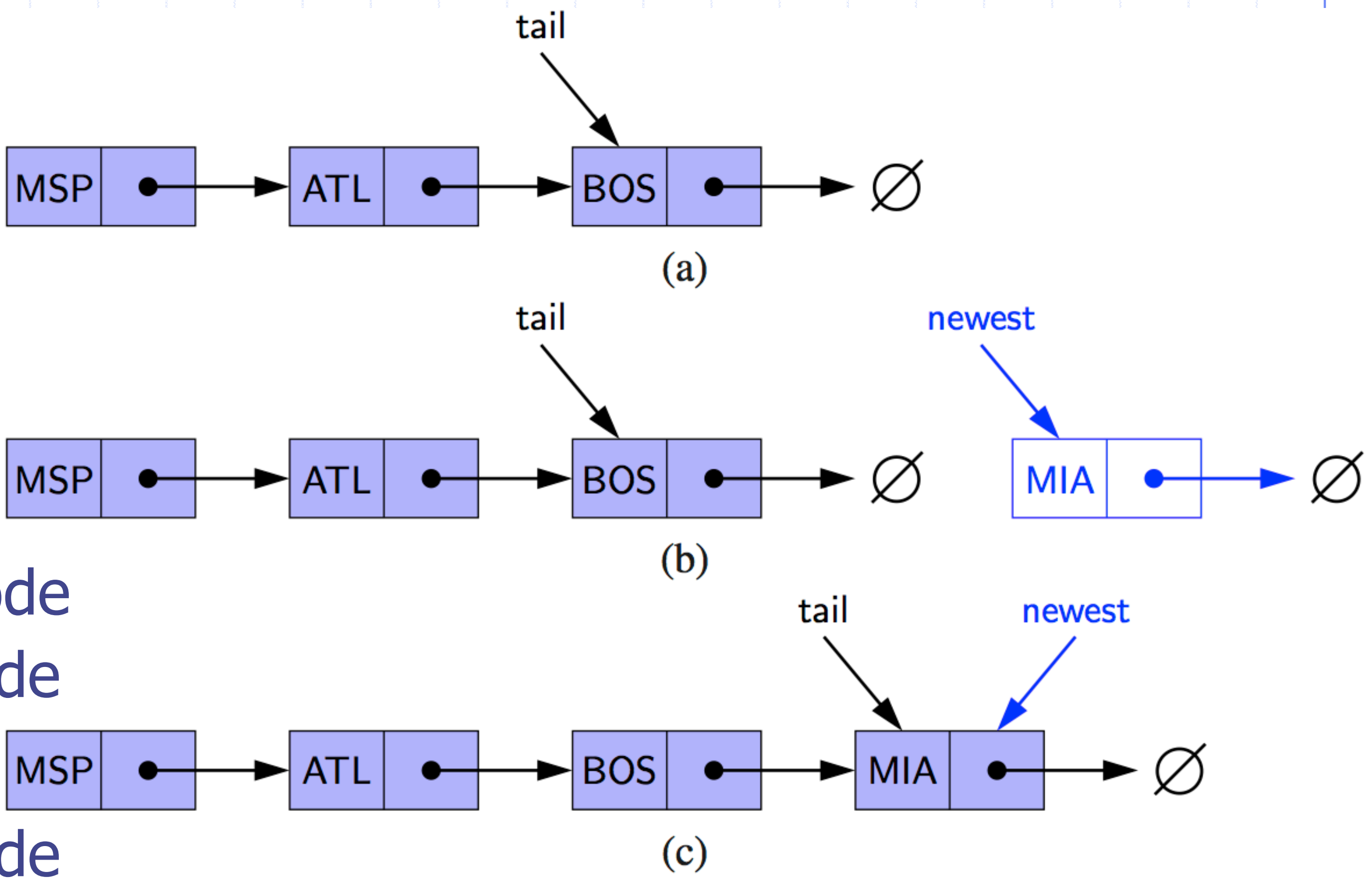
- Allocate new node
- Insert new element
- Have new node point to old head
- Update head to point to new node



(a) (b) (c)

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

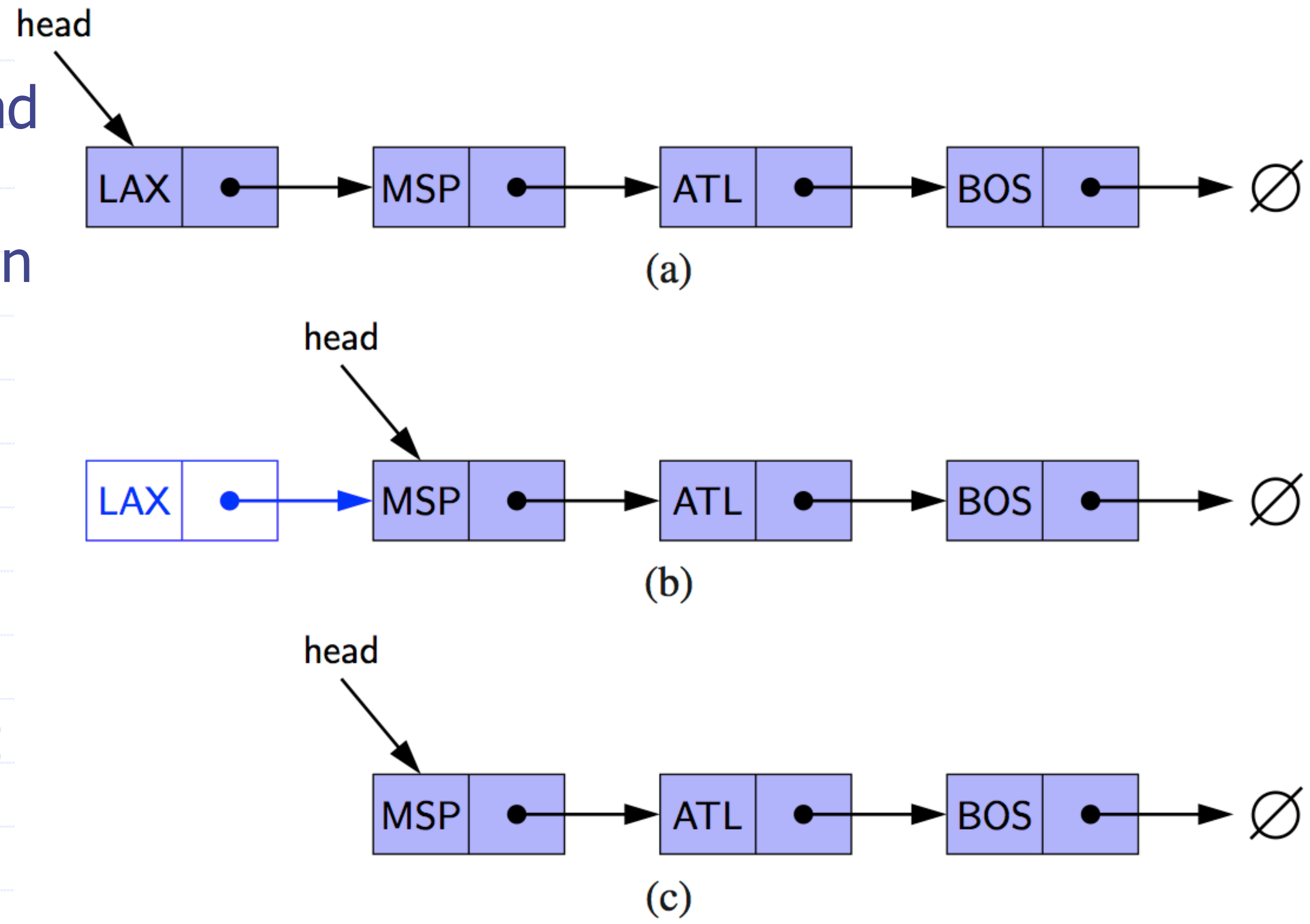


Java Methods

```
public void addFirst(E e) {                  // adds element e to the front of the list
  head = new Node<>(e, head);                // create and link a new node
  if (size == 0)
    tail = head;                             // special case: new node becomes tail also
  size++;
}
public void addLast(E e) {                   // adds element e to the end of the list
  Node<E> newest = new Node<>(e, null);      // node will eventually be the tail
  if (isEmpty())
    head = newest;                           // special case: previously empty list
  else
    tail.setNext(newest);                    // new node after existing tail
  tail = newest;                             // new node becomes the tail
  size++;
}
```

Removing at the Head

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

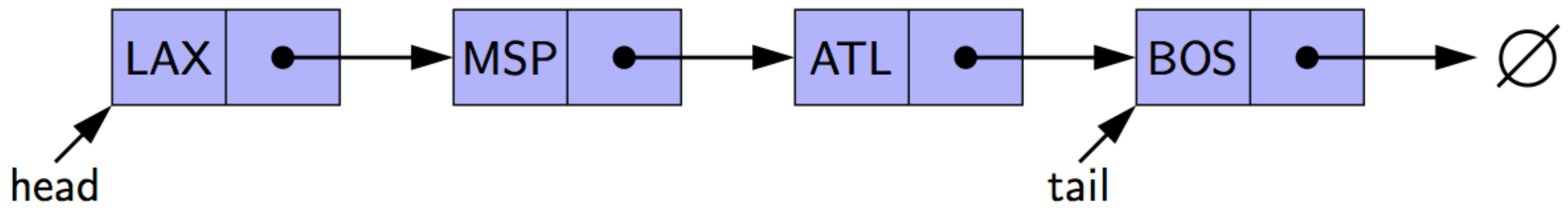


Java Method

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

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


LAX
MSP
ATL
BOS
∅
head
tail