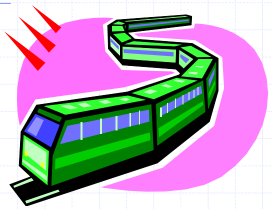
Lists



Position ADT (§ 5.2.2)

- The Position ADT models the notion of place within a data structure where a single object is stored
- It gives a unified view of diverse ways of storing data, such as
  - a cell of an array
  - a node of a linked list
- Just one method:
  - object element(): returns the element stored at the position

List ADT (§ 5.2.3)

- The List ADT models a sequence of positions storing arbitrary objects
- It establishes a before/after relation between positions
- Generic methods:
  - size(), isEmpty()

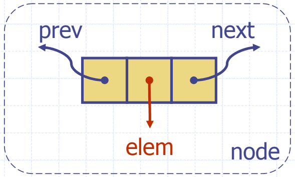
Accessor methods:

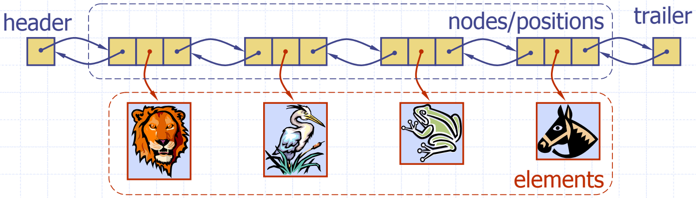
- first(), last()
- prev(p), next(p)

- Update methods:
  - replace(p, e)
  - insertBefore(p, e), insertAfter(p, e),
  - insertFirst(e), insertLast(e)
  - remove(p)

Doubly Linked List

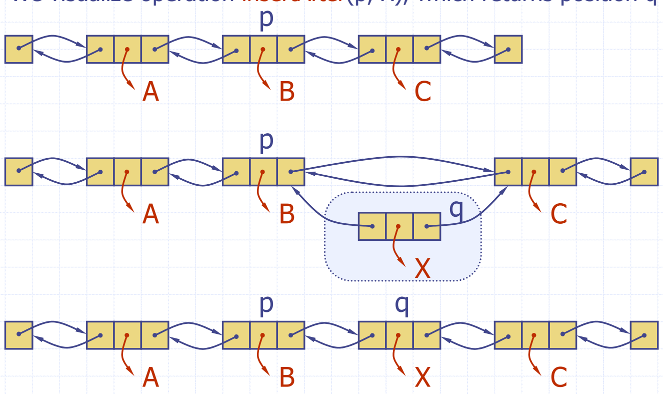
- A doubly linked list provides a natural implementation of the List ADT
- Nodes implement Position and store:
  - element
  - link to the previous node
  - link to the next node
- Special trailer and header nodes





Insertion

- We visualize operation insertAfter(p, X), which returns position q

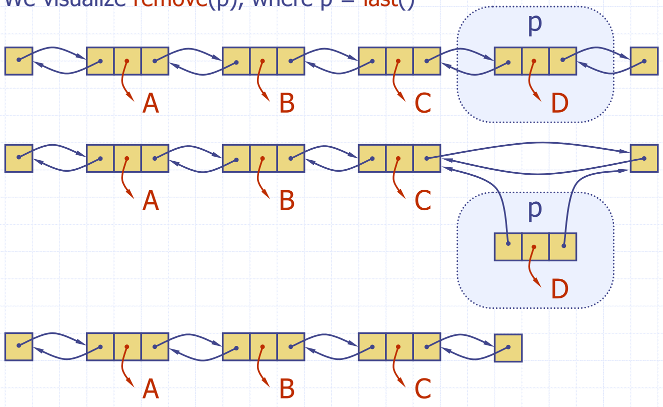


Insertion Algorithm

```
Algorithm insertAfter(p,e):
    Create a new node v
    v.setElement(e)
    v.setPrev(p)            {link v to its predecessor}
    v.setNext(p.getNext())  {link v to its successor}
    (p.getNext()).setPrev(v) {link p's old successor to v}
    p.setNext(v)            {link p to its new successor, v}
    return v   {the position for the element e}
```

Deletion

- We visualize remove(p), where p = last()



Deletion Algorithm

```
Algorithm remove(p):
    t = p.element        {a temporary variable to hold the
                          return value}
    (p.getPrev()).setNext(p.getNext())     {linking out p}
    (p.getNext()).setPrev(p.getPrev())
    p.setPrev(null)    {invalidating the position p}
    p.setNext(null)
    return t
```

Performance

- In the implementation of the List ADT by means of a doubly linked list
  - The space used by a list with n elements is $O(n)$
  - The space used by each position of the list is $O(1)$
  - All the operations of the List ADT run in $O(1)$ time
  - Operation element() of the Position ADT runs in $O(1)$ time