CHAPTER 3:
LINKED LISTS & RECURSION

LINKED LISTS

STORING HIGHEST SCORES

- Suppose you want to build a software that stores the **highest 10 scores** in a game

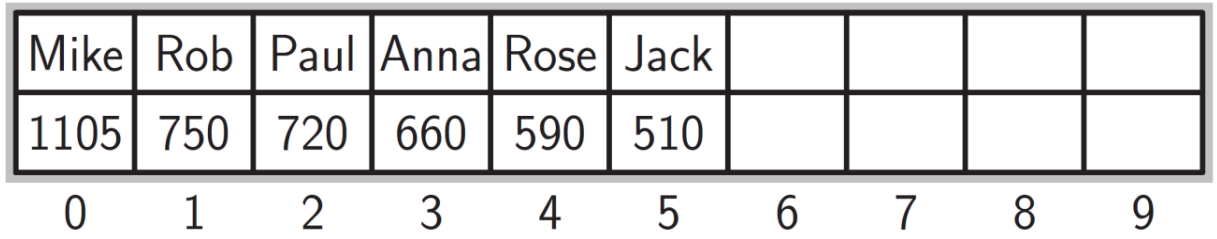
- One way to do so is using arrays in which every element is an object that has two data members:
  1. The player's name
  2. The player's score

- Suppose that, so far, 6 players played your game. The array may look like this:

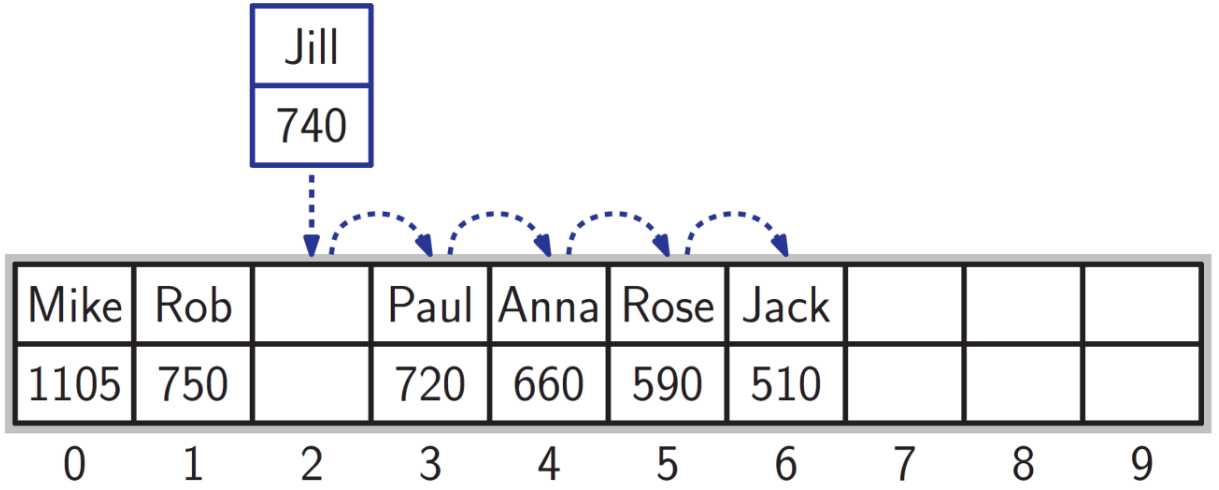
Mike	Rob	Paul	Anna	Rose	Jack				
1105	750	720	660	590	510				
0	1	2	3	4	5	6	7	8	9

STORING HIGHEST SCORES

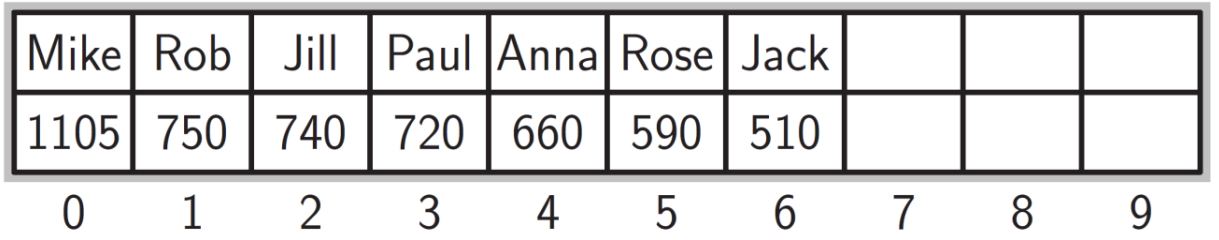
- Now, suppose that a new player, Jill, plays the game and scores 740. **How will you update the list?**



- You can **shift** the players, one by one, to create an empty slot, and then add Jill's object in this slot:

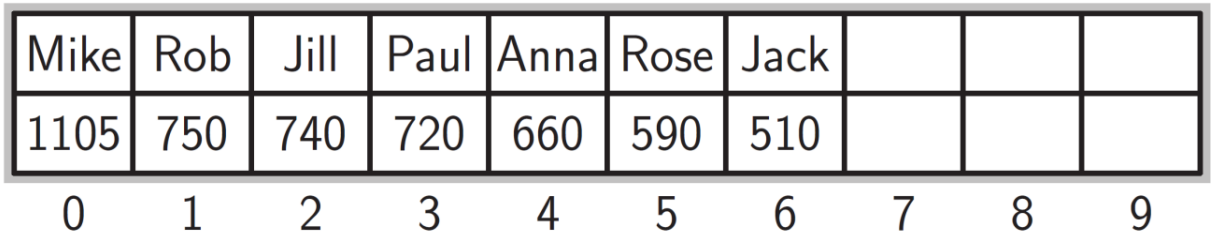


- The list would now look like this:

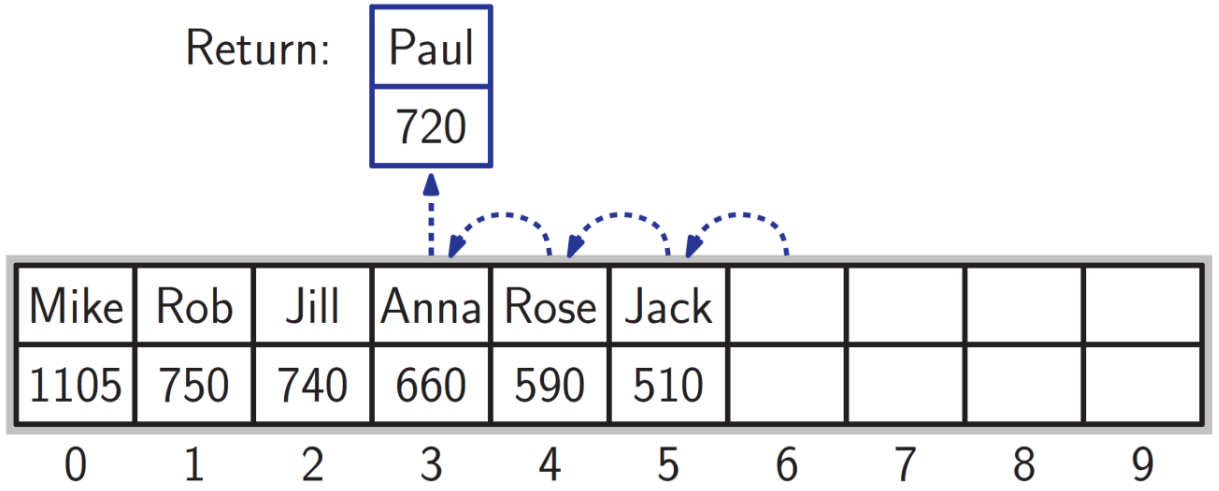


STORING HIGHEST SCORES

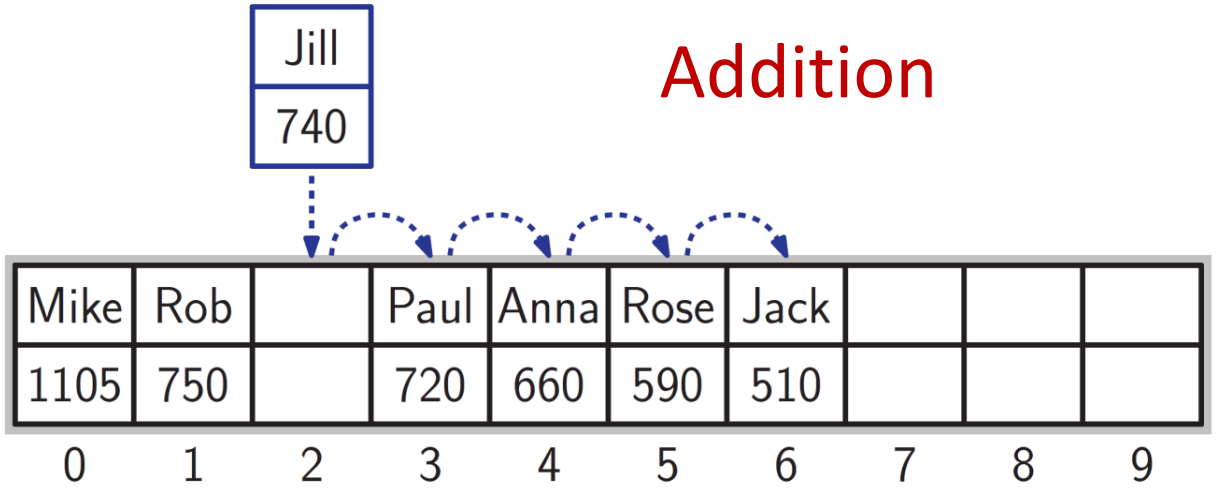
- Suppose we want to **remove** the object of, say, Paul from the list. **How will you update the list?**

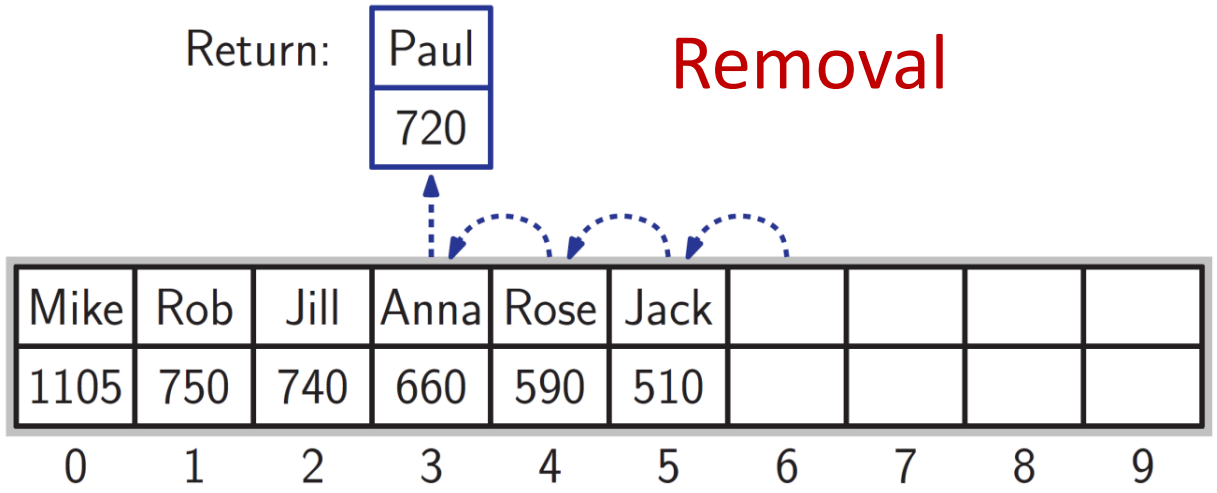


- You can **shift** the players one by one, just like we did earlier:



- Here is a **summary** of addition and removal.
- Do you think this is **computationally efficient?**
- **No!** because the shifting involves too many operations!
- **Example:** if the list contained 500,000 entries, then depending on the location of the element that is being added or removed, you may end up shifting hundreds of thousands of elements, just to make a tiny update to the list!
- **Solution:** Use a "Linked list"!

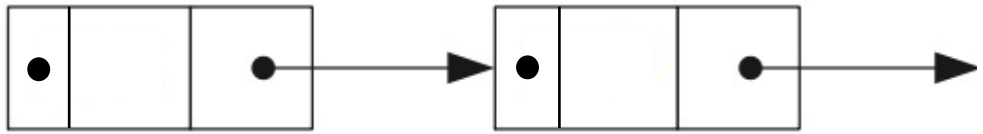




LINKED LISTS

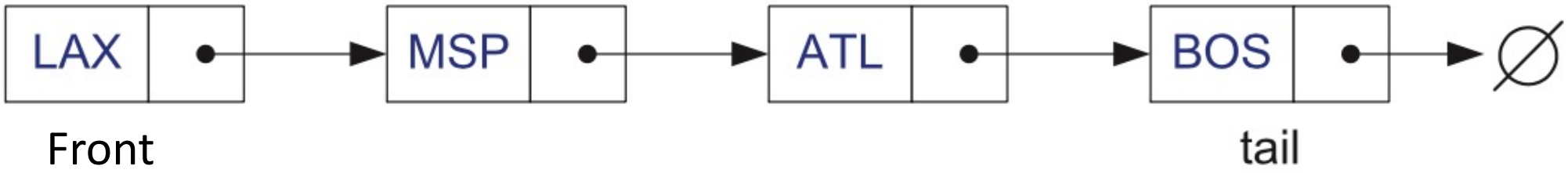
- A linked list is a data structure consisting of a chain of **nodes**

- Each node stores **data element**, in addition to at least one **pointer** that points to the next node in the list



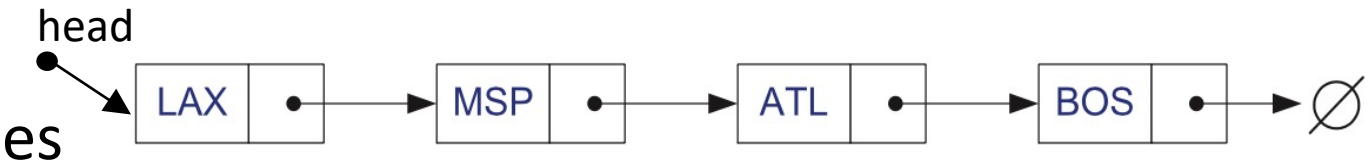
SINGLY LINKED LIST

- The first node = the node with the "front" element
- The last node = whose "*next*" points to NULL



- *No predetermined fixed size,* unlike arrays!
- It is called "**singly linked list**" because each node stores a single link (pointer)!

IMPLEMENTATION



Let's see how to implement these classes

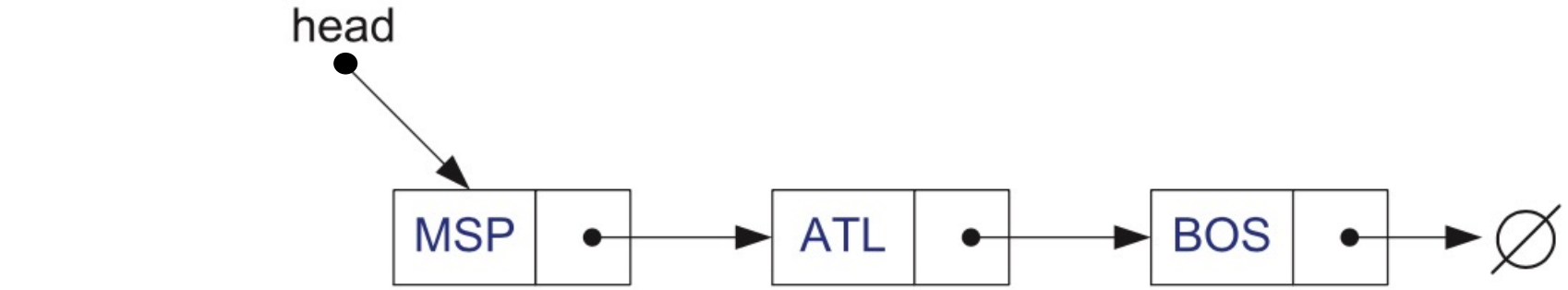
```
class StringNode { // An object of this class is one node
private:
   string elem;                    // element value
   StringNode* next;               // pointer to the next node
friend class StringLinkedList;  // Now, an object of StringLinkedlist can access
};                                 // the node's private members "elem" and "next"

class StringLinkedList { // An object of this class is a singly linked list
private:
   StringNode* head;  // this is a pointer that points to the front
public:
   StringLinkedList():head(NULL){}; // constructor; sets head = NULL
   ~StringLinkedList();             // destructor; clears the memory
   bool empty() const;              // returns "true" if the list is empty
   const string& front() const;     // returns the element at the front
   void addFront(const string& e);  // puts "e" in a node, and adds it to the front
   void removeFront();              // deletes the node at the front of the list
};
```

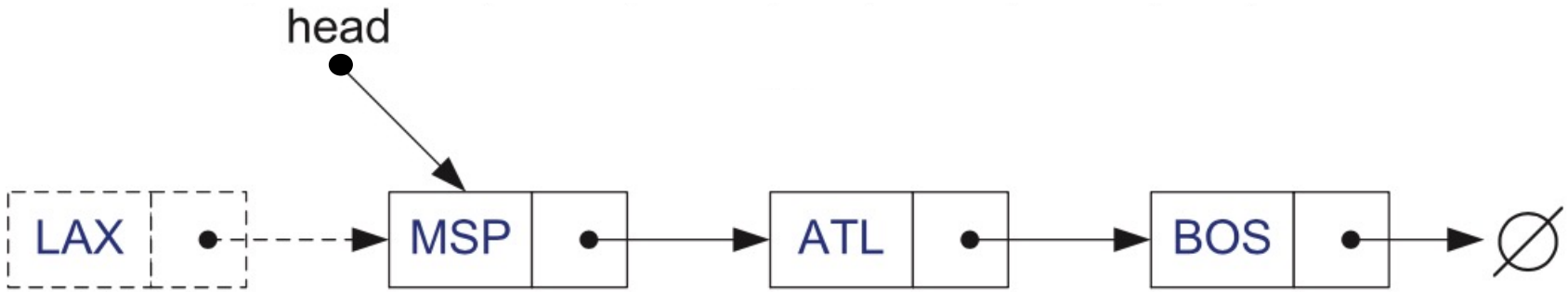
The head is implemented as the pointer that points to the first node

SINGLY LINKED LIST:
INSERTION TO THE FRONT

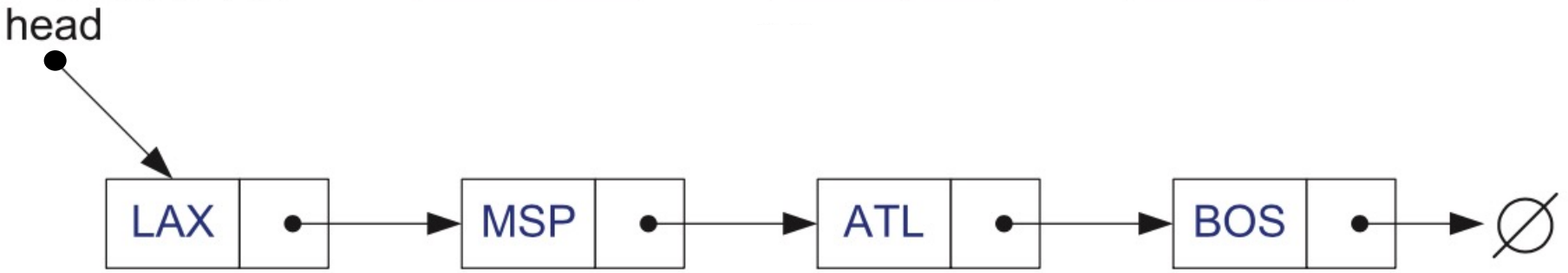
Before insertion



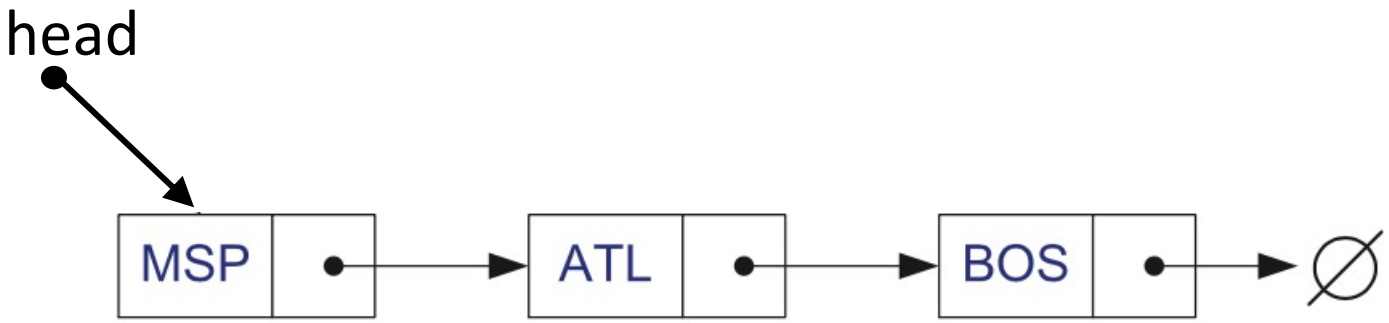
During insertion



After insertion



SINGLY LINKED LIST:
INSERTION TO THE FRONT



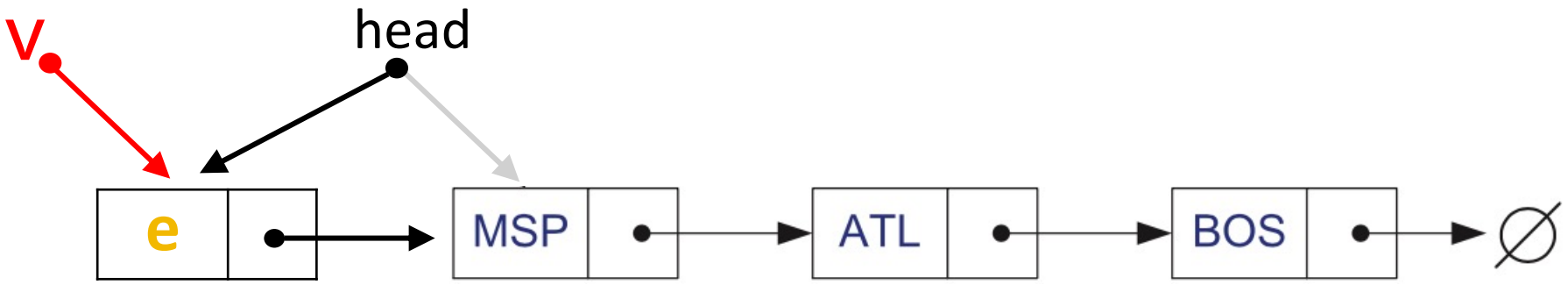
How would you implement this?

```
void StringLinkedList::addFront(const string& e) {



}
```

SINGLY LINKED LIST:
INSERTION TO THE FRONT

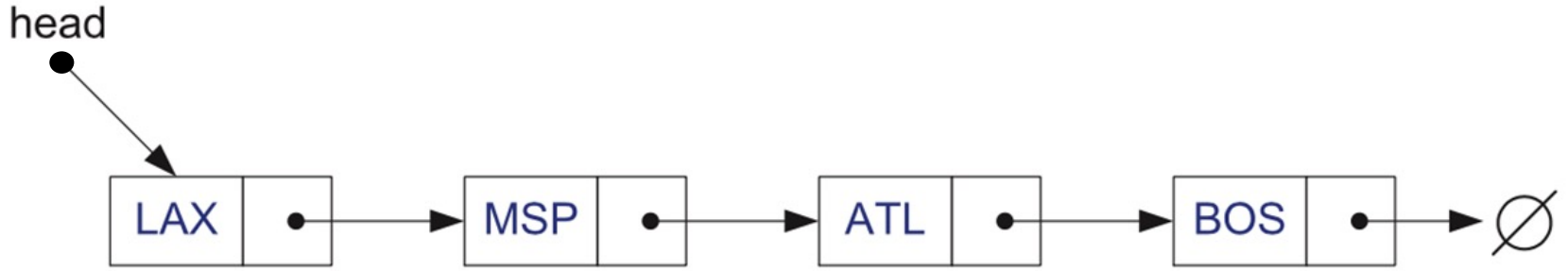


How would you implement this?

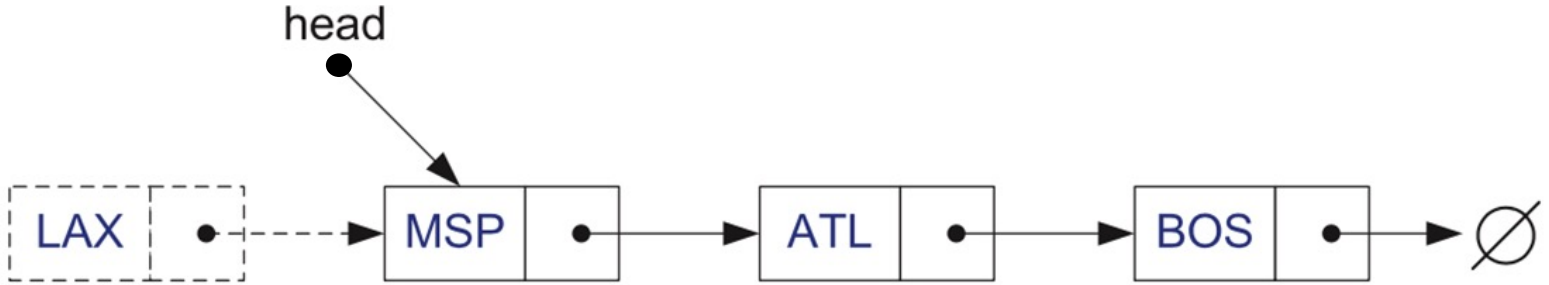
```
void StringLinkedList::addFront(const string& e) {
    StringNode* v = new StringNode; // create new node, “v”
    v->elem = e; // store “e” in the node “v”
    v->next = head; // Now, “v” point to the front of the list
    head = v; // set “v” to be the new head
}
```

SINGLY LINKED LIST:
DELETION TO THE FRONT

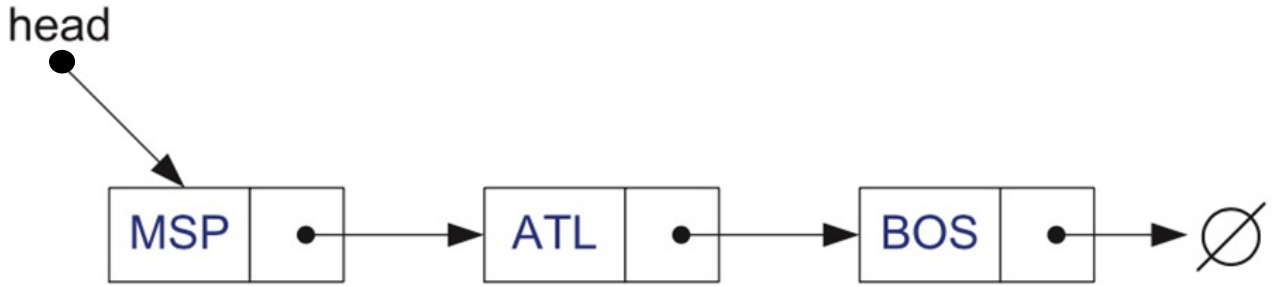
Before deletion



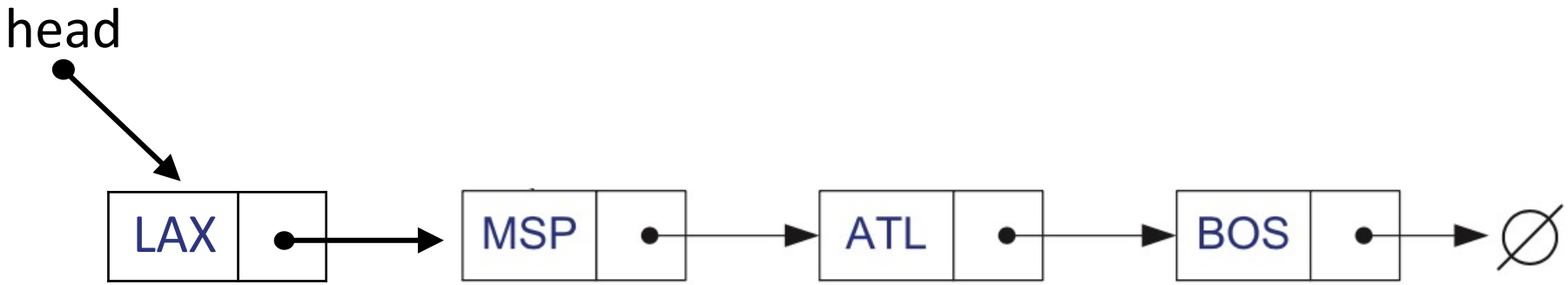
During deletion



After deletion



SINGLY LINKED LIST: DELETION TO THE FRONT



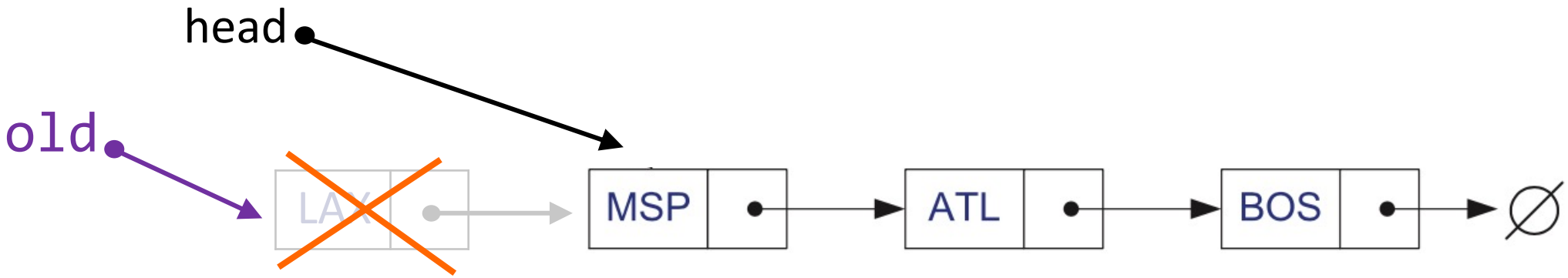
How would you implement this?

```
void StringLinkedList::removeFront() {



}
```

SINGLY LINKED LIST:
DELETION TO THE FRONT



How would you implement this?

```
void StringLinkedList::removeFront() {
    StringNode* old = head; //save current front (pointed to by head)
    head = old->next;       //skip over old front
    delete old;             //delete the old front
}
```