Lecture # 2

LIST Data Structure

- The List is among the most generic of data structures.
- In Real life:
  - shopping list,
  - groceries list,
  - list of people to invite to dinner
  - List of presents to get

Lists

- A list is collection of items that are all of the same type (grocery items, integers, names)
- The items, or elements of the list, are stored in some particular order
- It is possible to insert new elements into various positions in the list and remove any element of the list

Lists

- List is a set of elements in a linear order.
  For example, data values a1, a2, a3, a4 can be arranged in a list:

  (a3, a1, a2, a4)

  In this list, a3, is the first element, a1 is the second element, and so on

- The order is important here; this is not just a random collection of elements, it is an *ordered* collection

List Operations

Useful operations

- createList(): create a new list (presumably empty)
- copy(): set one list to be a copy of another
- clear(); clear a list (remove all elements)
- insert(X, ?): Insert element X at a particular position in the list
- remove(?): Remove element at some position in the list
- get(?): Get element at a given position
- update(X, ?): replace the element at a given position with X
- find(X): determine if the element X is in the list
- length(): return the length of the list.

List Operations

- We need to decide what is meant by "particular position"; we have used "?" for this.
- There are two possibilities:
  - Use the actual index of element: insert after element 3, get element number 6. This approach is taken by arrays
  - Use a "current" marker or pointer to refer to a particular position in the list.

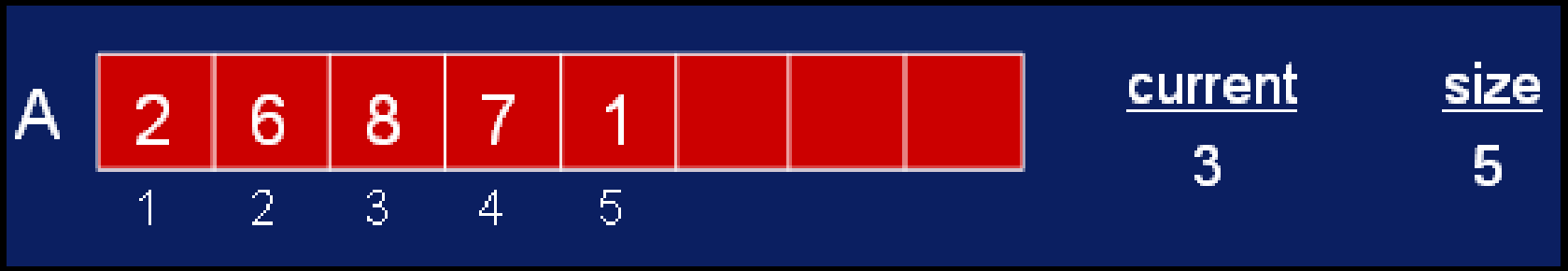
List Operations

- If we use the "current" marker, the following four methods would be useful:

- **start()**: moves to "current" pointer to the very first element.
- **tail()**: moves to "current" pointer to the very last element.
- **next**(): move the current position forward one element
- **back**(): move the current position backward one element

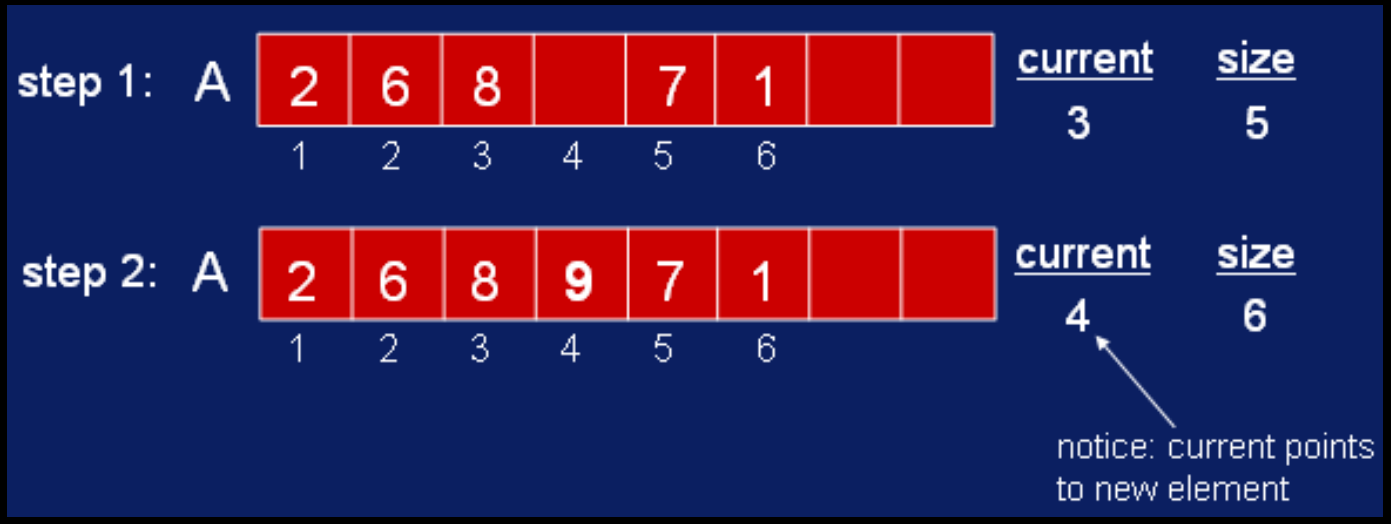
Implementing Lists

- We have designed the interface for the List; we now must consider how to implement that interface.
- Implementing Lists using an array: for example, the list of integers (2, 6, 8, 7, 1) could be represented as:



List Implementation

- add(9); current position is 3. The new list would thus be: (2, 6, 8, 9, 7, 1)
- We will need to *shift* everything to the right of 8 one place to the right to make place for the new element '9'.



Implementing Lists

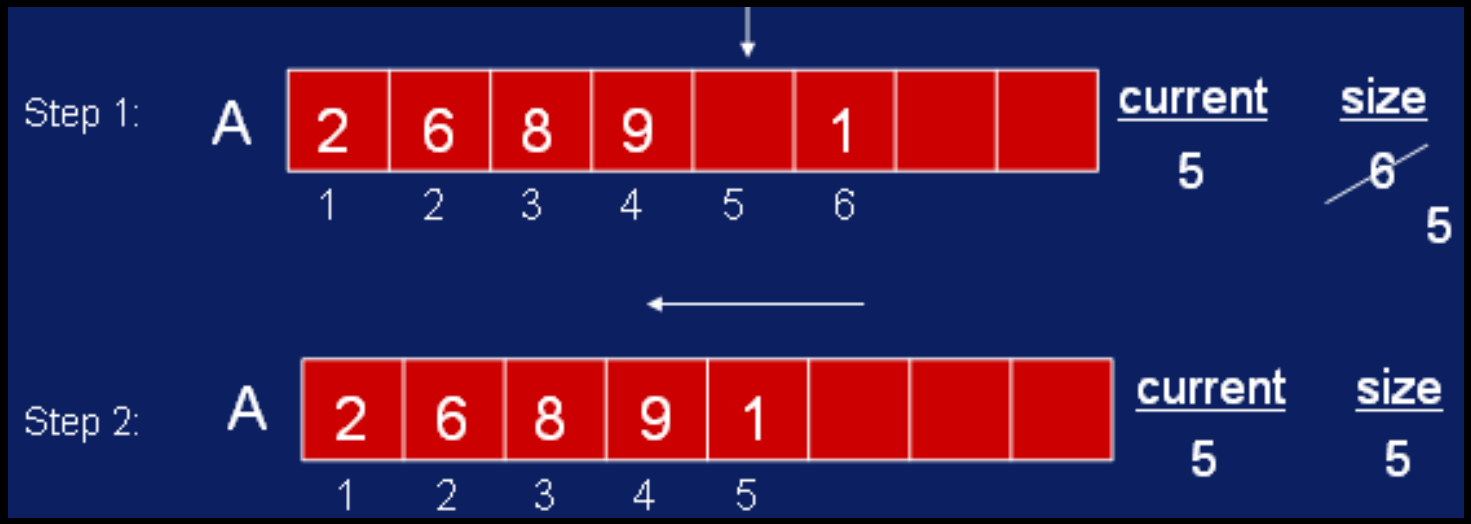
- next():

Implementing Lists

- There are special cases for positioning the current pointer:
  - past the last array cell
  - before the first cell
- We will have to worry about these when we write the actual code.

Implementing Lists

- remove(): removes the element at the current index



- We fill the blank spot left by the removal of 7 by shifting the values to the right of position 5 over to the left one space

Implementing Lists

- find(X): traverse the array until X is located.

```
int find(int X)
{
      int j;
      for(j=1; j < size+1; j++ )
          if( A[j] == X ) break;

      if( j < size+1 )
     {    // found X
          current = j;      // current points to where X found
          return 1;          // 1 for true
      }
      return 0;  // 0 (false) indicates not found
}
```

NOTE: The code considers that the array starts at index 1.

Implementing Lists

- Other operations:

```
get()       → return A[current];
update(X)   → A[current] = X;
length()    →  return size;
back()      → current--;
start()     → current = 1;
end()       → current = size;
```

List Using Linked Memory

- Various cells of memory are not allocated consecutively in memory.
- Array is Not enough to store the future elements of the list after full exhaust of array locations.
- With arrays, the second element was right next to the first element.
- Now in Linked Memory approach, the first element must *explicitly* tell us where to look for the second element.
- Do this by holding the memory address of the second element