Lecture 8: ADT List

CS2504/CS4092– Algorithms and Linear Data Structures

Dr. Kieran T. Herley

Department of Computer Science
University College Cork

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Summary

The concept of a list and ADT List. Definition and usage of ADT. Array-based implementation of ADT.

Lists in the Real World

List An ordered finite sequence of items

Examples

- Class list: list of names
- To-do/shopping list: list of tasks/goods
- First *n* digits of π: list of digits
- Book: list of chapters; chapter: list of paragraphs; paragraph: list of sentences; sentence: list of words

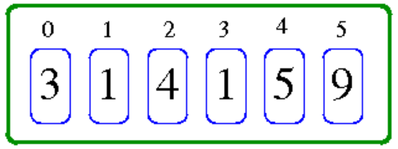
Notes

- Order is significant– $(3, 1, 4, 1) \neq (1, 4, 3, 1)$
- Duplicate items allowed

ADT List

ADT List Container type; represents indexed sequence of elements of some type; supports operations to get/set specified elements as well as add and remove elements.

Pic



Note This is a simplified cousin of Java's array-list concept

ADT List

A list is a container capable of holding an ordered arrangement of elements. The *index* of an element is the number of elements that preceed it in the list.

get(inx): Return the element at specified index. Illegal if no such index exists[1]. *Input: int; Output: E.*

set(inx, newElt): Replace the element at specified index with newElt. Return the old element at that index. Illegal if no such index exists[1]. *Input: int, E; Output: E.*

add(inx, newElt): Add element newElt to the list at index inx. Illegal if inx is negative or greater than current list size[1]. *Input: int, E; Output: None.*

remove(inx): Remove the element at the specified index from the list and return it. Illegal if no such index exists[1]. *Input: int; Output: E.*

ADT List also supports some other ops (incl. size, isEmpty), see handout for complete list.

List Ops. Illustrated

Operation	**Output**	L
add(0, 7)	-	(7_0)
add(0, 4)	-	$(4_0, 7_1)$
get(1)	7	$(4_0, 7_1)$
add(2, 2)	-	$(4_0, 7_1, 2_2)$
get(3)	Error	$(4_0, 7_1, 2_2)$
remove(1)	7	$(4_0, 2_1)$
add(1, 5)	-	$(4_0, 5_1, 2_2)$
add(1, 3)	-	$(4_0, 3_1, 5_2, 2_3)$
add(4, 9)	-	$(4_0, 3_1, 5_2, 2_3, 9_4)$
get(2)	5	$(4_0, 3_1, 5_2, 2_3, 9_4)$
set(3, 8)	2	$(4_0, 3_1, 5_2, 8_3, 9_4)$

Note: subscripts indicate indices

Simple List Manipulation

Goal Algorithm that traverses a list of numbers and deletes all the odd numbers.

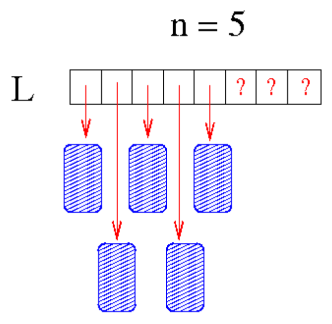
Algorithm

```
Algorithm RemoveOdds(L):
  i ← 0
  while i < L.size() do
     if odd(L.get(i)) then
        L.remove(i)
     else
        i ← i + 1
```

Why "else"?

Implementing ADT List

Representation



L left-justified array of elements

n the number of elements in the list

Implementation

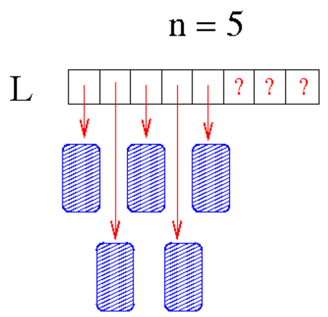
Construction create array; inialize *n* to zero

get/set probe/change specified index in array

add make room for element by shifting others rightwards as necessary; insert new elt. in specified index; increment *n*

remove extract specified element; shift others leftwards as necessary to delete; decrement *n*

Simple Operations

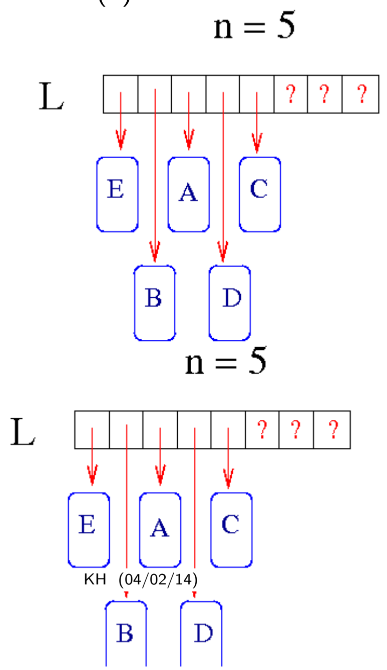


```
Algorithm size:
    return n;
Algorithm isEmpty:
    return (n = 0)
Algorithm get(i):
    return L[i]
Algorithm set(i, elt):
    old ←L[i]
    L[i] ←elt
    return old
```

Error checking (e.g. illegal indices) omitted

Method remove

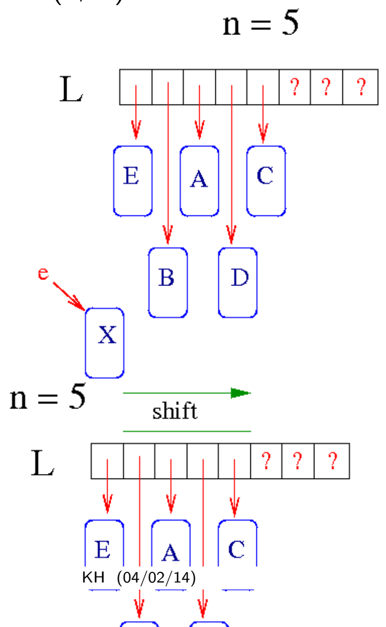
remove(1)



```
Algorithm remove(i):
    e ←L[i]
    for j = i to n−2 do
```

Method add

add(1, X):



List/ArrayBasedList (Simplified)

```
public interface List<EltType>
{   . . .
    public EltType get(int inx);
    . . .
}
```

```
public class ArrayBasedList<EltType>
        implements List<EltType>
{   public ArrayBasedList()
    {   numElts = 0;
        capacity =   INIT_CAP;
        elements = (EltType[])
            (new Object[capacity]);
    }

    . . .

    public EltType get(int inx)
    {   . . .
        return elements[inx];
    }

    private static final int
INIT_CAP = 10;
    private int capacity;
    protected EltType elements[];
    protected int numElts;
}
```

See web page for complete implementation.