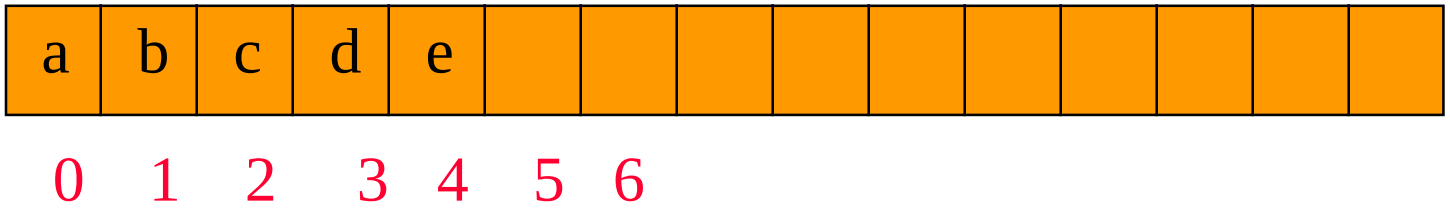
ArrayLinearList – Implementation

Data structures

Fall 2018

Linear List -Array Representation

use a one-dimensional array element[]



L = (a, b, c, d, e)

Store element i of list in element[i].

The Class ArrayLinearList

- General purpose implementation of linear lists.
- Unknown number of lists.

Create An Empty List

```
ArrayLinearList a = new ArrayLinearList(100),
                b = new ArrayLinearList(),
                c;
LinearList d = new ArrayLinearList(1000),
           e = new ArrayLinearList(),
           f;
```

Using A Linear List

```
System.out.println(a.size());
a.add(0, new Integer(2));
b.add(0, new Integer(4));
System.out.println(a);
b.remove(0);
if (a.isEmpty())
    a.add(0, new Integer(5));
```

Array Of Linear Lists

```
LinearList [] x = new LinearList [4];
x[0] = new ArrayLinearList(20);
x[1] = new Chain();
x[2] = new Chain();
x[3] = new ArrayLinearList();
for (int i = 0; i < 4; i++)
    x[i].add(0, new Integer(i));
```

The Class ArrayLinearList

```
/** array implementation of LinearList */
package dataStructures;
import java.util.*;    // has Iterator interface
import utilities.*;    // has array resizing class

public class ArrayLinearList implements LinearList
{
     // data members
         protected Object [] element;  // array of elements
         protected int size;    // number of elements in array
    // constructors and other methods come here
}
```

A Constructor

```
/** create a list with initial capacity initialCapacity
   * @throws IllegalArgumentException when
   * initialCapacity < 1 */
  public ArrayLinearList(int initialCapacity)
   {
      if (initialCapacity < 1)
         throw new IllegalArgumentException
                        ("initialCapacity must be >= 1");
      // size has the default initial value of 0
      element = new Object [initialCapacity];
   }
```

Another Constructor

```
/** create a list with initial capacity 10 */
  public ArrayLinearList()
  {// use default capacity of 10
    this(10);
  }
```

The Method isEmpty

```
/** @return true iff list is empty */
 public boolean isEmpty()
    {return size == 0;}
```

The Method size()

```
/** @return current number of elements in list */
 public int size()
     {return size;}
```

The Method checkIndex

```
/** @throws IndexOutOfBoundsException when
  * index is not between 0 and size - 1 */
 void checkIndex(int index)
 {
   if (index < 0 || index >= size)
     throw new IndexOutOfBoundsException
          ("index = " + index + "  size = " + size);
 }
```

The Method get

```
/** @return element with specified index
  * @throws IndexOutOfBoundsException when
  * index is not between 0 and size - 1 */
 public Object get(int index)
 {
   checkIndex(index);
   return element[index];
 }
```

The Method indexOf

```
/** @return index of first occurrence of theElement,
  * return -1 if theElement not in list */
 public int indexOf(Object theElement)
 {
   // search element[] for theElement
   for (int i = 0; i < size; i++)
      if (element[i].equals(theElement))
         return i;

   // theElement not found
   return -1;
 }
```

The Method remove

```
public Object remove(int index)
 {
    checkIndex(index);

    // valid index, shift elements with higher index
    Object removedElement = element[index];
    for (int i = index + 1; i < size; i++)
       element[i-1] = element[i];

    element[--size] = null;   // enable garbage collection
    return removedElement;
 }
```

The Method add

```
public void add(int index, Object theElement)
   {
     if (index < 0 || index > size)
       // invalid list position
       throw new IndexOutOfBoundsException
             ("index = " + index + "  size = " + size);

     // valid index, make sure we have space
     if (size == element.length)
       // no space, double capacity
       element = ChangeArrayLength.changeLength1D(element, 2 *
                                                          size);
```

The Method add

```
 // shift elements right one position
   for (int i = size - 1; i >= index; i--)
      element[i + 1] = element[i];

   element[index] = theElement;

   size++;
}
```

Faster Way To Shift Elements 1 Right

```
System.arraycopy(element, index, element,
                 index + 1, size - index);
```

Convert To A String

```
public String toString()
 {
   StringBuffer s = new StringBuffer("[");
   // put elements into the buffer
   for (int i = 0; i < size; i++)
      if (element[i] == null) s.append("null, ");
      else s.append(element[i].toString() + ", ");
   if (size > 0) s.delete(s.length() - 2, s.length());
                  // remove last ", "
   s.append("]");
   // create equivalent String
   return new String(s);
 }
```

Iterators

An iterator permits you to examine the elements of a data structure one at a time.

Iterator Methods

Iterator ix = x.iterator();

constructs and initializes an iterator to examine the elements of x;
constructed iterator is assigned to ix

you must define the method iterator in the class for x

Iterator Methods

ix.hasNext()

returns true iff x has a next element

ix.next()

throws NoSuchElementException if there is no next element

returns next element otherwise

Optional Iterator Method

ix.remove()

removes last element returned by ix.next()

throws UnsupportedMethodException if method not implemented

throws IllegalStateException if ix.next() not yet called or did not return an element

Using An Iterator

```
Iterator ix = x.iterator();
while (ix.hasNext())
    examine(ix.next());
```

vs

```
for (int i = 0; i < x.size(); i++)
    examine(x.get(i));
```

Merits Of An Iterator

- it is often possible to implement the method next so that its complexity is less than that of get
- many data structures do not have a get by index method
- iterators provide a uniform way to sequence through the elements of a data structure

Java's Array Linear List Class

java.util.ArrayList

Cadillac version of our
ArrayLinearListWithIterator