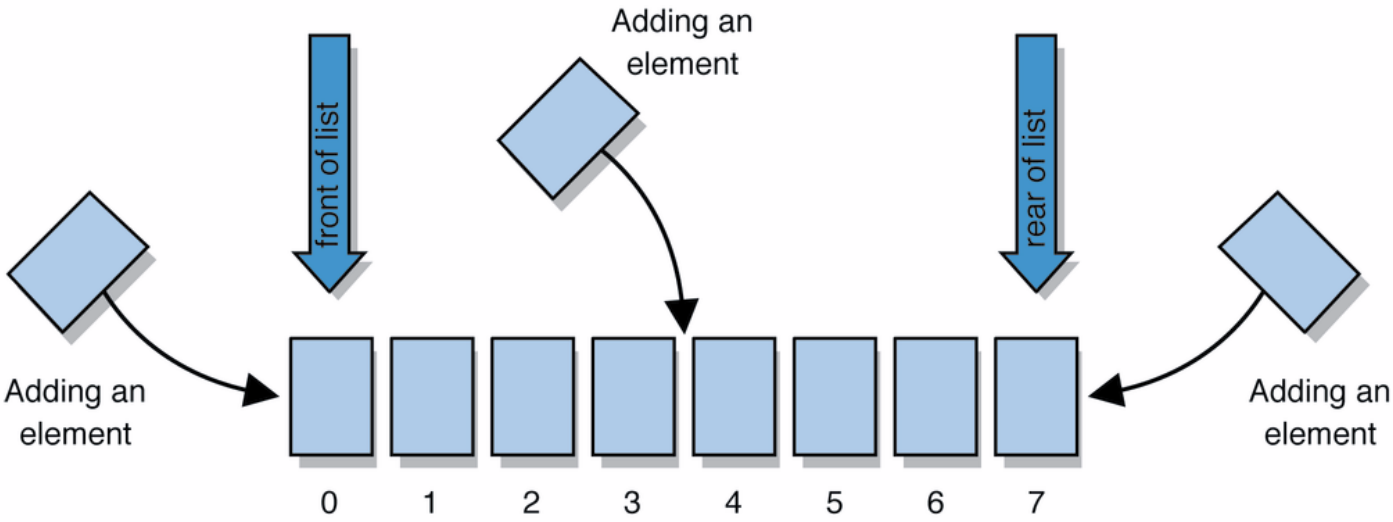
Lists

- a collection storing a sequence of elements
  - each element is accessible by a 0-based **index**
  - a list has a **size** (# of elements present)
  - element can be added to the front, back, or elsewhere
  - in Java, a list can be represented as an **`ArrayLinearList`** object



Linear List

Method Summary

void **addToFront**(java.lang.Object element)
Adds the given element to the front of the current list

void **addToRear**(java.lang.Object element)
Adds the given element to the rear of the current list

boolean **isEmpty**()
Predicate returns true if the list is empty and false otherwise

java.lang.Object **removeFront**()
Removes the first element in the list and returns a reference to it.

java.lang.Object **removeRear**()
Removes the last element in the list and returns a reference to it.

int **size**()
Returns the number of nodes in the list

java.lang.String **toString**()
Returns a string representation of the list.

Create an empty List

```
ArrayLinearList a = new ArrayLinearList(100);

        b = new ArrayLinearList()
```

The class ArrayLinearList

```
/** array implementation of  LinearList */
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);
    // copy the element to be deleted
    Object removedElement = element[index];
     // valid index, shift elements with higher index
    for (int i = index + 1; i < size; i++)
       element[i-1] = element[i];

    size=size-1;
     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; // insert element

  size++;
}
```

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);
 }
```

Conclusions

Advantages

- Quick insertion – insert at last – O(1)
- Very fast access if index known – O(1)

Disadvantages

- Slow search - O(n)
- Slow deletion - O(n)
- Fixed size- need dynamic array