Oct 10

Assignment 5

Comp 2230\_02

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2024



**COMP 2230 – Data Structures and Algorithm Analysis**

Assignment #5: Lists

## Due Date: October. 17th S01 and October 18th for S02

**Chapter 15**

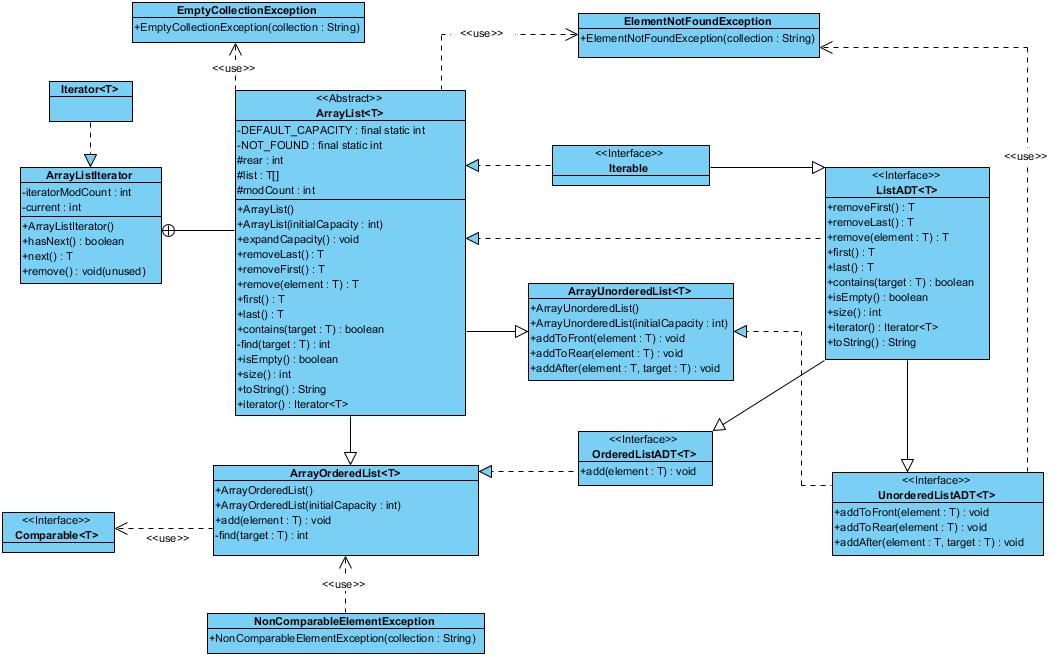
**Problem 1**: Complete the implementation of the Array List Class.

* **expandCapacity**
* **removeLast**
* **removeFrist**
* **first**
* **last**
* **isEmpty**
* **size**
* **toString**

**Problem 2**: Complete the implementation of the ArrayUnordered List Class.

* **addToFront**
* **adddToRear**

**Problem 3**: Override the **Find** method in the ArrayOrdered List Class to stop early if an item is not in the list, if encounter a larger item then the target is not in the list.

**Chapter** **15**

**Problem #1 Code**

\*\*see problems #2 and #3 for testing of ArrayList.java class

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| **ArrayList.java**  package Ass5\_2230;  import Ass5\_2230.exceptions.\*;  import java.util.\*;  /\*\*  \* ArrayList represents an array implementation of a list. The front of  \* the list is kept at array index 0. This class will be extended  \* to create a specific kind of list.  \*  \* @author Java Foundations  \* @version 4.0  \*/  public abstract class ArrayList<T> implements ListADT<T>, Iterable<T>  {  private final static int DEFAULT\_CAPACITY = 100;  private final static int NOT\_FOUND = -1;  protected int rear;  protected T[] list;  protected int modCount;  /\*\*  \* Creates an empty list using the default capacity.  \*/  public ArrayList()  {  this(DEFAULT\_CAPACITY);  }  /\*\*  \* Creates an empty list using the specified capacity.  \*  \* @param initialCapacity the integer value of the size of the array list  \*/  public ArrayList(int initialCapacity)  {  rear = 0;  list = (T[])(new Object[initialCapacity]);  modCount = 0;  }  /\*\*  \* Creates a new array to store the contents of this list with  \* twice the capacity of the old one. Called by descendant classes  \* that add elements to the list.  \*/  protected void expandCapacity()  {  list = Arrays.copyOf(list, 2 \* list.length);  }  /\*\*  \* Removes and returns the last element in this list.  \*  \* @return the last element in the list  \* @throws EmptyCollectionException if the element is not in the list  \*/  public T removeLast() throws EmptyCollectionException  {  if (isEmpty()) throw new EmptyCollectionException("ArrayList");  rear--;  modCount++;  T result = list[rear];  list[rear] = null;  return result;  }  /\*\*  \* Removes and returns the first element in this list.  \*  \* @return the first element in the list  \* @throws EmptyCollectionException if the element is not in the list  \*/  public T removeFirst() throws EmptyCollectionException {  if (isEmpty()) throw new EmptyCollectionException("ArrayList");  T result = list[0];  rear--;    // shift elements down  for (int scan = 0; scan < rear; scan++)  list[scan] = list[scan+1];  list[rear] = null;  modCount++;  return result;  }  /\*\*  \* Removes and returns the specified element.  \*  \* @param element the element to be removed and returned from the list  \* @return the removed element  \* @throws ElementNotFoundException if the element is not in the list  \*/  public T remove(T element)  {  T result;  int index = find(element);  if (index == NOT\_FOUND)  throw new ElementNotFoundException("ArrayList");  result = list[index];  rear--;  // shift the appropriate elements  for (int scan = index; scan < rear; scan++)  list[scan] = list[scan+1];  list[rear] = null;  modCount++;  return result;  }  /\*\*  \* Returns a reference to the element at the front of this list.  \* The element is not removed from the list. Throws an  \* EmptyCollectionException if the list is empty.  \*  \* @return a reference to the first element in the list  \* @throws EmptyCollectionException if the list is empty  \*/  public T first() throws EmptyCollectionException  {  if (isEmpty()) throw new EmptyCollectionException("ArrayList");  return list[0];  }  /\*\*  \* Returns a reference to the element at the rear of this list.  \* The element is not removed from the list. Throws an  \* EmptyCollectionException if the list is empty.  \*  \* @return a reference to the last element of this list  \* @throws EmptyCollectionException if the list is empty  \*/  public T last() throws EmptyCollectionException  {  if (isEmpty()) throw new EmptyCollectionException("ArrayList");  return list[rear - 1];  }  /\*\*  \* Returns true if this list contains the specified element.  \*  \* @param target the target element  \* @return true if the target is in the list, false otherwise  \*/  public boolean contains(T target)  {  return (find(target) != NOT\_FOUND);  }  /\*\*  \* Returns the array index of the specified element, or the  \* constant NOT\_FOUND if it is not found.  \*  \* @param target the target element  \* @return the index of the target element, or the  \* NOT\_FOUND constant  \*/  private int find(T target)  {  int scan = 0;  int result = NOT\_FOUND;  if (!isEmpty())  while (result == NOT\_FOUND && scan < rear)  if (target.equals(list[scan]))  result = scan;  else  scan++;  return result;  }  /\*\*  \* Returns true if this list is empty and false otherwise.  \*  \* @return true if the list is empty, false otherwise  \*/  public boolean isEmpty()  {  return size() == 0;  }  /\*\*  \* Returns the number of elements currently in this list.  \*  \* @return the number of elements in the list  \*/  public int size()  {  return rear;  }  /\*\*  \* Returns a string representation of this list.  \*  \* @return the string representation of the list  \*/  public String toString()  {  return "Front -> " + Arrays.toString(list) + " <- Rear";  }  /\*\*  \* Returns an iterator for the elements currently in this list.  \*  \* @return an iterator for the elements in the list  \*/  public Iterator<T> iterator()  {  return new ArrayListIterator();  }  /\*\*  \* ArrayListIterator iterator over the elements of an ArrayList.  \*/  private class ArrayListIterator implements Iterator<T> {  int iteratorModCount;  int current;  /\*\*  \* Sets up this iterator using the specified modCount.  \*  \* @param modCount the current modification count for the ArrayList  \*/  public ArrayListIterator() {  iteratorModCount = modCount;  current = 0;  }  /\*\*  \* Returns true if this iterator has at least one more element  \* to deliver in the iteration.  \*  \* @return true if this iterator has at least one more element to deliver  \* in the iteration  \* @throws ConcurrentModificationException if the collection has changed  \* while the iterator is in use  \*/  public boolean hasNext() throws ConcurrentModificationException {  if (iteratorModCount != modCount)  throw new ConcurrentModificationException();  return (current < rear);  }  /\*\*  \* Returns the next element in the iteration. If there are no  \* more elements in this iteration, a NoSuchElementException is  \* thrown.  \*  \* @return the next element in the iteration  \* @throws NoSuchElementException if an element not found exception occurs  \* @throws ConcurrentModificationException if the collection has changed  \*/  public T next() throws ConcurrentModificationException {  if (!hasNext())  throw new NoSuchElementException();  current++;  return list[current - 1];  }  /\*\*  \* The remove operation is not supported in this collection.  \*  \* @throws UnsupportedOperationException if the remove method is called  \*/  public void remove() throws UnsupportedOperationException {  throw new UnsupportedOperationException();  }  }  } |

**Problem #2 Code**

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| **ArrayUnorderedList.java**  package Ass5\_2230;  import Ass5\_2230.exceptions.\*;  import java.util.Iterator;  /\*\*  \* ArrayUnorderedList represents an array implementation of an unordered list.  \*  \* @author Java Foundations  \* @version 4.0  \*/  public class ArrayUnorderedList<T> extends ArrayList<T> implements UnorderedListADT<T>  {  /\*\*  \* Creates an empty list using the default capacity.  \*/  public ArrayUnorderedList()  {  super();  }  /\*\*  \* Creates an empty list using the specified capacity.  \*  \* @param initialCapacity the initial size of the list  \*/  public ArrayUnorderedList(int initialCapacity)  {  super(initialCapacity);  }  /\*\*  \* Adds the specified element to the front of this list.  \*  \* @param element the element to be added to the front of the list  \*/  public void addToFront(T element)  {  if(size() == list.length){  expandCapacity();  }  for(int i = rear; i > 0; i--){  list[i] = list[i - 1];  }  list[0] = element;  rear++;  modCount++;  }  /\*\*  \* Adds the specified element to the rear of this list.  \*  \* @param element the element to be added to the list  \*/  public void addToRear(T element)  {  if(size() == list.length){  expandCapacity();  }  list[rear] = element;  rear++;  modCount++;  }  /\*\*  \* Adds the specified element after the specified target element.  \* Throws an ElementNotFoundException if the target is not found.  \*  \* @param element the element to be added after the target element  \* @param target the target that the element is to be added after  \*/  public void addAfter(T element, T target) throws ElementNotFoundException  {  if (size() == list.length)  expandCapacity();  int scan = 0;  // find the insertion point  while (scan < rear && !target.equals(list[scan]))  scan++;  if (scan == rear)  throw new ElementNotFoundException("UnorderedList");  scan++;  // shift elements up one  for (int shift = rear; shift > scan; shift--)  list[shift] = list[shift - 1];  // insert element  list[scan] = element;  rear++;  modCount++;  }  } |

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| **UnorderedArrayListTest.java**  package Ass5\_2230;  import Ass5\_2230.exceptions.\*;  public class UnorderedArrayListTest {  public static void main(String[] args) {  ArrayUnorderedList<String> list = new ArrayUnorderedList<String>(10);  // Test addToRear method  System.out.println("Testing addToRear method:");  list.addToRear("Apple");  list.addToRear("Banana");  list.addToRear("Cherry");  System.out.println("List after adding to rear: " + list);  System.out.println("Size: " + list.size());  System.out.println();  // Test addToFront method  System.out.println("Testing addToFront method:");  list.addToFront("Dragon Fruit");  System.out.println("List after adding to front: " + list);  System.out.println();  // Test addAfter method  System.out.println("Testing addAfter method:");  list.addAfter("Elderberry", "Banana");  System.out.println("List after adding 'Elderberry' after 'Banana': " + list);  System.out.println();  // Test first and last methods  System.out.println("Testing first and last methods:");  System.out.println("First element: " + list.first());  System.out.println("Last element: " + list.last());  System.out.println();  // Test remove methods  System.out.println("Testing remove methods:");  System.out.println("Removed first element: " + list.removeFirst());  System.out.println("Removed last element: " + list.removeLast());  System.out.println("List after removals: " + list);  System.out.println();  // Test contains method  System.out.println("Testing contains method:");  System.out.println("Contains 'Banana': " + list.contains("Banana"));  System.out.println("Contains 'Pear': " + list.contains("Pear"));  System.out.println();  // Test iterator  System.out.println("Testing iterator:");  System.out.print("Elements: ");  for (String element : list) {  System.out.print(element + " ");  }  System.out.println("\n");  // Test remove by element  System.out.println("Testing remove by element:");  System.out.println("Removing 'Banana': " + list.remove("Banana"));  System.out.println("List after removal: " + list);  System.out.println();  // Test empty list behavior  System.out.println("Testing empty list behavior:");  try {  while (!list.isEmpty()) {  list.removeLast();  }  System.out.println("List is empty: " + list.isEmpty());  list.first(); // This should throw an exception  } catch (EmptyCollectionException e) {  System.out.println("The EmptyCollectionException is thrown correctly");  }  // Test addAfter with non-existent target  System.out.println("\nTesting addAfter with non-existent target:");  try {  list.addToRear("Apple");  list.addAfter("Grape", "Pear");  } catch (ElementNotFoundException e) {  System.out.println("The ElementNotFoundException is thrown correctly");  }  }  } |

**Problem #2 Test Output**

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**Problem #3 Code**

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| **ArrayOrderedList.java**  package Ass5\_2230;  import Ass5\_2230.exceptions.\*;  /\*\*  \* ArrayOrderedList represents an array implementation of an ordered list.  \*  \* @author Java Foundations  \* @version 4.0  \*/  public class ArrayOrderedList<T> extends ArrayList<T>  implements OrderedListADT<T>  {  /\*\*  \* Creates an empty list using the default capacity.  \*/  public ArrayOrderedList()  {  super();  }  /\*\*  \* Creates an empty list using the specified capacity.  \*  \* @param initialCapacity the initial size of the list  \*/  public ArrayOrderedList(int initialCapacity)  {  super(initialCapacity);  }  /\*\*  \* Adds the specified Comparable element to this list, keeping  \* the elements in sorted order.  \*  \* @param element the element to be added to the list  \*/  public void add(T element)  {  if (!(element instanceof Comparable))  throw new NonComparableElementException("OrderedList");  Comparable<T> comparableElement = (Comparable<T>)element;  if (size() == list.length)  expandCapacity();  int scan = 0;  // find the insertion location  while (scan < rear && comparableElement.compareTo(list[scan]) > 0)  scan++;  // shift existing elements up one  for (int shift = rear; shift > scan; shift--)  list[shift] = list[shift - 1];  // insert element  list[scan] = element;  rear++;  modCount++;  }  private <T extends Comparable<T>> int find(T target){  int index = 0;  if (target == null)  throw new NonComparableElementException("OrderedList");  if(!isEmpty()){  while (index < rear && target.compareTo((T) list[index]) <= 0) {  if (target.compareTo((T) list[index]) == 0) {  return index;  }  index++;  }  }  return -1;  }  } |

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| **OrderedListTest.java**  package Ass5\_2230;  import Ass5\_2230.exceptions.\*;  public class OrderedListTest {  public static void main(String[] args) {  ArrayOrderedList<Integer> list = new ArrayOrderedList<Integer>(5);  // Test add method and expand capacity  System.out.println("Testing add method and expand capacity:");  list.add(7);  list.add(85);  list.add(1);  list.add(15);  list.add(7);  list.add(42);  System.out.println("List after adding: " + list);  System.out.println("Size: " + list.size());  System.out.println();  // Test first and last methods  System.out.println("Testing first and last methods:");  System.out.println("First element: " + list.first());  System.out.println("Last element: " + list.last());  System.out.println();  // Test remove methods  System.out.println("Testing remove methods:");  System.out.println("Removed first element: " + list.removeFirst());  System.out.println("Removed last element: " + list.removeLast());  System.out.println("List after removals: " + list);  System.out.println();  // Test contains method  System.out.println("Testing contains method:");  System.out.println("Contains 15: " + list.contains(15));  System.out.println("Contains 102: " + list.contains(102));  System.out.println();  // Test iterator  System.out.println("Testing iterator:");  System.out.print("Elements: ");  for (Integer element : list) {  System.out.print(element + " ");  }  System.out.println("\n");  // Test remove by element  System.out.println("Testing remove by element:");  System.out.println("Removing 15: " + list.remove(15));  System.out.println("List after removal: " + list);  System.out.println();  // Test empty list behavior  System.out.println("Testing empty list behavior:");  try {  while (!list.isEmpty()) {  list.removeLast();  }  System.out.println("List is empty: " + list.isEmpty());  list.first(); // This should throw an exception  } catch (EmptyCollectionException e) {  System.out.println("The EmptyCollectionException is thrown correctly");  }  }  } |

**Problem #3 Test Output**

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