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Assignment 4

COMP 2230_02

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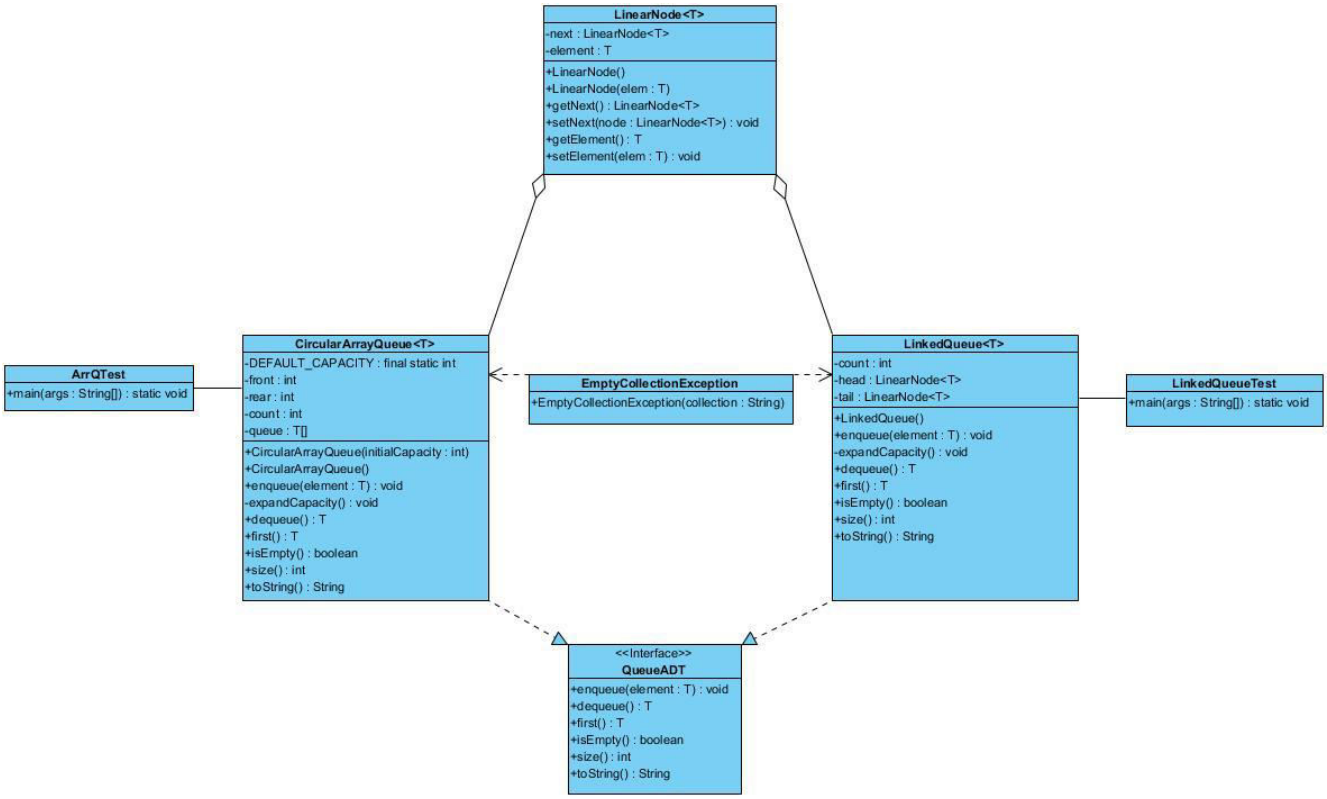
COMP 2230 – Data Structures and Algorithm Analysis

Assignment #4: Queues

Due Date: Section 01 Oct 3rd, Section 02 Oct 4th

Chapter 14: coding:



Problem 1:

Implementation of the first(), size(), isEmpty(), and toString() methods into the LinkedQueue class.

Problem 2:

Implementation of the first(), size(), isEmpty(), and toString() methods into the CircularArrayQueue class.

Problem #1 Code

LinkedQueue.java

```
package Ass4_2230;

import Ass4_2230.exceptions.*;

/**
 * LinkedQueue represents a linked implementation of a queue.
 *
 * @author Java Foundations
 * @version 4.0
 */
public class LinkedQueue<T> implements QueueADT<T>
{
	private int count;
	private LinearNode<T> head, tail;

	/**
	 * Creates an empty queue.
	 */
	public LinkedQueue()
	{
		count = 0;
		head = tail = null;
	}

	/**
	 * Adds the specified element to the tail of this queue.
	 * @param element the element to be added to the tail of the queue
	 */
	public void enqueue(T element)
	{
		LinearNode<T> node = new LinearNode<T>(element);

		if (isEmpty())
			head = node;
		else
```

```
            tail.setNext(node);

        tail = node;
        count++;
    }

    /**
     * Removes the element at the head of this queue and returns a
     * reference to it.
     * @return the element at the head of this queue
     * @throws EmptyCollectionException if the queue is empty
     */
    public T dequeue() throws EmptyCollectionException
    {
        if (isEmpty())
            throw new EmptyCollectionException("queue");

        T result = head.getElement();
        head = head.getNext();
        count--;

        if (isEmpty())
            tail = null;

        return result;
    }

    /**
     * Returns a reference to the element at the head of this queue.
     * The element is not removed from the queue.
     * @return a reference to the first element in this queue
     * @throws EmptyCollectionsException if the queue is empty
     */
    public T first() throws EmptyCollectionException
    {
        if(isEmpty()){
            throw new EmptyCollectionException("queue");
        }
        return head.getElement();
```

```
    }

    /**
     * Returns true if this queue is empty and false otherwise.
     * @return true if this queue is empty
     */
    public boolean isEmpty()
    {
        // To be completed as a Programming Project

        return count == 0;
    }

    /**
     * Returns the number of elements currently in this queue.
     * @return the number of elements in the queue
     */
    public int size()
    {
        // To be completed as a Programming Project

        return count;
    }

    /**
     * Returns a string representation of this queue.
     * @return the string representation of the queue
     */
    public String toString()
    {
        // To be completed as a Programming Project
        String result = "";
        LinearNode<T> current = head;
        for (int i = 1; i <= count; i++) {
            result += current.getElement() + ",";
            current = current.getNext();
        }

        return result;
```

```
     }
}
```

LinkedQueueTest.java

```
package Ass4_2230;

import Ass2_2230.exceptions.EmptyCollectionException;


public class LinkedQueueTest {
    public static void main(String[] args){
        LinkedQueue<Integer> linkQ = new LinkedQueue<>();
        //empty stack initialization
        System.out.println("empty Queue: Front <- " + linkQ.toString() + "
<- Rear");
        for(int i = 1; i < 6; i++){
            linkQ.enqueue(i);

        }
        System.out.println("Filled Queue: " + "Front <- " +
linkQ.toString() + " <- Rear");

        //test dequeue and first
        System.out.println("-----dequeue() & first() Test-----");
        System.out.println("first Value: " + linkQ.first());
        for (int i = 1; i < 5; i++) {
            linkQ.dequeue();
        }
        System.out.println("Queue after dequeue test: " + "Front <- " +
linkQ.toString() + " <- Rear");
        System.out.println("Top Value after dequeue test: " +
linkQ.first());
        linkQ.dequeue();

        //test first with empty method
        System.out.println("-----first() with empty stack test-----");
        try{
            linkQ.first();
        } catch (EmptyCollectionException e) {
```

```
            System.out.println("first() throws empty collection exception
correctly");
        }

        //test dequeue with empty stack
        System.out.println("-----dequeue() with empty stack test-----");
        try {
            linkQ.dequeue();
        } catch (EmptyCollectionException e) {
            System.out.println("dequeue() throws empty collection exception
correctly");
        }
        System.out.println("Is the queue empty: " + linkQ.isEmpty());
        System.out.println("queue size: " + linkQ.size());

    }
}
```

Problem #1 Test Output

```
C:\WINDOWS\SYSTEM32\cmd

empty Queue: Front <-  <- Rear
Filled Queue: Front <- 1,2,3,4,5, <- Rear
-----dequeue() & first() Test-----
first Value: 1
Queue after dequeue test: Front <- 5, <- Rear
Top Value after dequeue test: 5
-----first() with empty stack test-----
first() throws empty collection exception correctly
-----dequeue() with empty stack test-----
dequeue() throws empty collection exception correctly
Is the queue empty: true
queue size: 0


------------------
(program exited with code: 0)

Press any key to continue . . .
```

Problem #2 Code

CircularArrayQueue.java

```
package Ass4_2230;

import Ass4_2230.exceptions.*;

import java.util.Arrays;


/**
 * CircularArrayQueue represents an array implementation of a queue in
 * which the indexes for the front and rear of the queue circle back to 0
 * when they reach the end of the array.
 *
 * @author Java Foundations
 * @version 4.0
 */
public class CircularArrayQueue<T> implements QueueADT<T>
{
     private final static int DEFAULT_CAPACITY = 100;
     private int front, rear, count;
     private T[] queue;

     /**
      * Creates an empty queue using the specified capacity.
      * @param initialCapacity the initial size of the circular array
queue
      */
     public CircularArrayQueue(int initialCapacity)
     {
          front = rear = count = 0;
          queue = (T[]) (new Object[initialCapacity]);
     }

     /**
      * Creates an empty queue using the default capacity.
      */
     public CircularArrayQueue()
```

```
    {
        this(DEFAULT_CAPACITY);
    }

    /**
     * Adds the specified element to the rear of this queue, expanding
     * the capacity of the queue array if necessary.
     * @param element the element to add to the rear of the queue
     */
    public void enqueue(T element)
    {
        if (size() == queue.length)
            expandCapacity();

        queue[rear] = element;
        rear = (rear + 1) % queue.length;

        count++;
    }

    /**
     * Creates a new array to store the contents of this queue with
     * twice the capacity of the old one.
     */
    private void expandCapacity()
    {
        T[] larger = (T[]) (new Object[queue.length * 2]);

        for (int scan = 0; scan < count; scan++)
        {
            larger[scan] = queue[front];
            front = (front + 1) % queue.length;
        }

        front = 0;
        rear = count;
        queue = larger;
    }
```

```
/**
 * Removes the element at the front of this queue and returns a
 * reference to it.
 * @return the element removed from the front of the queue
 * @throws EmptyCollectionException  if the queue is empty
 */
public T dequeue() throws EmptyCollectionException
{
     if (isEmpty())
          throw new EmptyCollectionException("queue");

     T result = queue[front];
     queue[front] = null;
     front = (front + 1) % queue.length;

     count--;

     return result;
}

/**
 * Returns a reference to the element at the front of this queue.
 * The element is not removed from the queue.
 * @return the first element in the queue
 * @throws EmptyCollectionException if the queue is empty
 */
public T first() throws EmptyCollectionException
{
     // To be completed as a Programming Project

     return queue[front];
}

/**
 * Returns true if this queue is empty and false otherwise.
 * @return true if this queue is empty
 */
public boolean isEmpty()
{
```

```
            // To be completed as a Programming Project

            return count == 0;
      }

      /**
       * Returns the number of elements currently in this queue.
       * @return the size of the queue
       */
      public int size()
      {
            // To be completed as a Programming Project

            return count;
      }

      /**
       * Returns a string representation of this queue.
       * @return the string representation of the queue
       */
      public String toString()
      {
            // To be completed as a Programming Project

            return Arrays.toString(queue);
      }
}
```

ArrQTest.java

```
package Ass4_2230;

import Ass2_2230.exceptions.EmptyCollectionException;

public class ArrQTest {
    public static void main(String[] args) {
        CircularArrayQueue<Integer> arrq = new CircularArrayQueue<>(5);

        // Initialization with null values and capacity 5
```

```
        System.out.println("Current Queue: Front <- " + arrq.toString() + "
<- Rear");

        // Populate the queue to fill the initial capacity
        for (int i = 1; i <= 5; i++) {
            arrq.enqueue(i);
        }
        System.out.println("Current Queue: Front <- " + arrq.toString() + "
<- Rear");

        // Test isEmpty and size
        System.out.println("Is the queue empty: " + arrq.isEmpty());
        System.out.println("Queue size: " + arrq.size());

        // Test expandCapacity() method
        System.out.println("-----expandCapacity() Test-----");
        for (int i = 6; i <= 10; i++) {
            arrq.enqueue(i);
        }
        System.out.println("Current Queue: Front <- " + arrq.toString() + "
<- Rear");

        // Test dequeue() and first() methods
        System.out.println("-----dequeue() & first() Test-----");
        System.out.println("First Value before dequeue: " + arrq.first());
        System.out.println("Queue before dequeue: Front <- " +
arrq.toString() + " <- Rear");
        for (int i = 0; i < 5; i++) {
            arrq.dequeue();
        }
        System.out.println("First Value after dequeue half the queue: " +
arrq.first());
        System.out.println("Queue after dequeue half the queue: Front <- "
+ arrq.toString() + " <- Rear");
        for (int i = 0; i < 5; i++) {
            arrq.dequeue();
        }
        System.out.println("First Value after dequeue the entire queue: " +
arrq.first());
        System.out.println("Queue after dequeue the entire queue: Front <-
" + arrq.toString() + " <- Rear");
```

```
        // Test first() with empty queue
        System.out.println("-----first() with empty queue test-----");
        try {
            arrq.first();
        } catch (EmptyCollectionException ece) {
            System.out.println("first() throws empty collection exception
correctly");
        }

        // Test dequeue() with empty queue
        System.out.println("-----dequeue() with empty queue test-----");
        try {
            arrq.dequeue();
        } catch (EmptyCollectionException ece) {
            System.out.println("dequeue() throws empty collection exception
correctly");
        }

        // Final checks
        System.out.println("Is the queue empty: " + arrq.isEmpty());
        System.out.println("Queue size: " + arrq.size());
    }
}
```

Problem #2 Test Output

```
C:\WINDOWS\SYSTEM32\cmd

Current Queue: Front <- [null, null, null, null, null] <- Rear
Current Queue: Front <- [1, 2, 3, 4, 5] <- Rear
Is the queue empty: false
Queue size: 5
-----expandCapacity() Test-----
Current Queue: Front <- [1, 2, 3, 4, 5, 6, 7, 8, 9, 10] <- Rear
-----dequeue() & first() Test-----
First Value before dequeue: 1
Queue before dequeue: Front <- [1, 2, 3, 4, 5, 6, 7, 8, 9, 10] <- Rear
First Value after dequeue half the queue: 6
Queue after dequeue half the queue: Front <- [null, null, null, null, null, 6, 7, 8, 9, 10] <- Rear
First Value after dequeue the entire queue: null
Queue after dequeue the entire queue: Front <- [null, null, null, null, null, null, null, null, null, null] <- Rear
-----first() with empty queue test-----
-----dequeue() with empty queue test-----
dequeue() throws empty collection exception correctly
Is the queue empty: true
Queue size: 0


------------------
(program exited with code: 0)

Press any key to continue . . .
```