The LinkedList Collection

LinkedList Example

1. **Use the constructor to create an empty linked list.**

```
LinkedList<String> aList = new LinkedList<String>();
```

2. **Assume the list contains the strings "Red", "Blue", "Green".**
   Output its size and check whether aList contains the color "White".

```
System.out.println("Size = " +  aList.size());
System.out.println("List contains the string 'White' is " +
                                   aList.contains("White");
```

```
Output:  Size = 3
         List contains the string 'White' is false
```

LinkedList Example (concluded)

**Add the color "Black" and a second element with color "Blue".
Then delete the first occurrence of "Blue".
An output statement uses toString() to list the elements in the sequence.**

```
aList.add("Black");              // add Black at the end
aList.add("Blue");               // add Blue at the end
aList.remove("Blue");            // delete first "Blue"
System.out.println(aList);       // uses toString()
```

```
Output: [Red, Green, Black, Blue]
```

LinkedList Index Methods

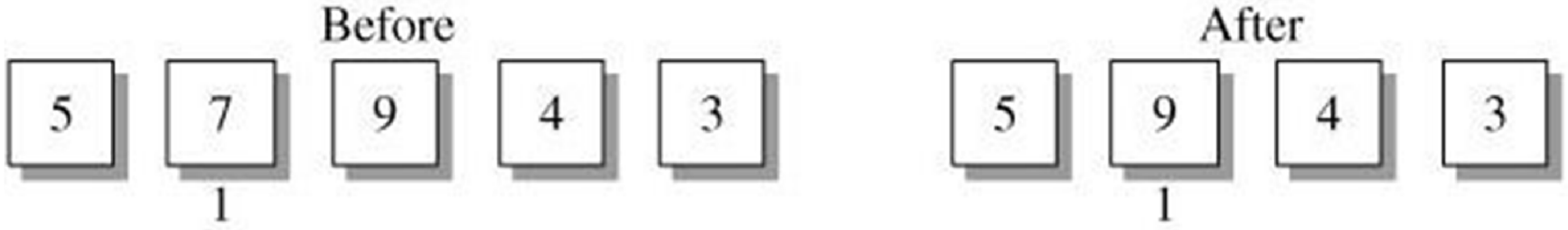
- The LinkedList class implements the indexed-based methods that characterize the List interface.
- A collection can access and update an element with the **`get()`** and **`set()`** methods and modify the list with the **`add(index, element)`** and **`remove(index)`** methods.
- The index methods have O(n) worst case running time. Use these methods only for small data sets.

LinkedList Index Methods Example

Assume the collection, list, initially contains elements with values [5, 7, 9, 4, 3].

Use get() to access the object at index 1 and then remove the element. The element at index 1 then has the value 9.

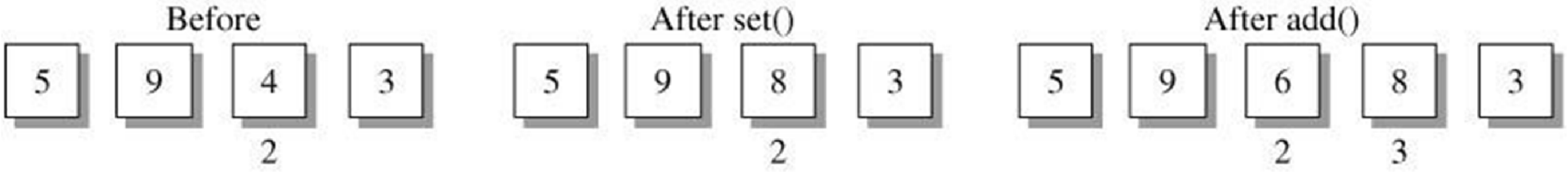
```
Integer intObj = list.get(1); // intObj has value 7
list.remove(1);
```



LinkedList Index Methods Example (concluded)

Use set() to update the element at index 2. Give it the value 8. Add a new element with value 6 at index 2. The new element occupies position 2, and its insertion shifts the tail of the list up one position. Thus the node at index 3 has value 8.

```
list.set(2, 8);
list.add(2, 6);
```



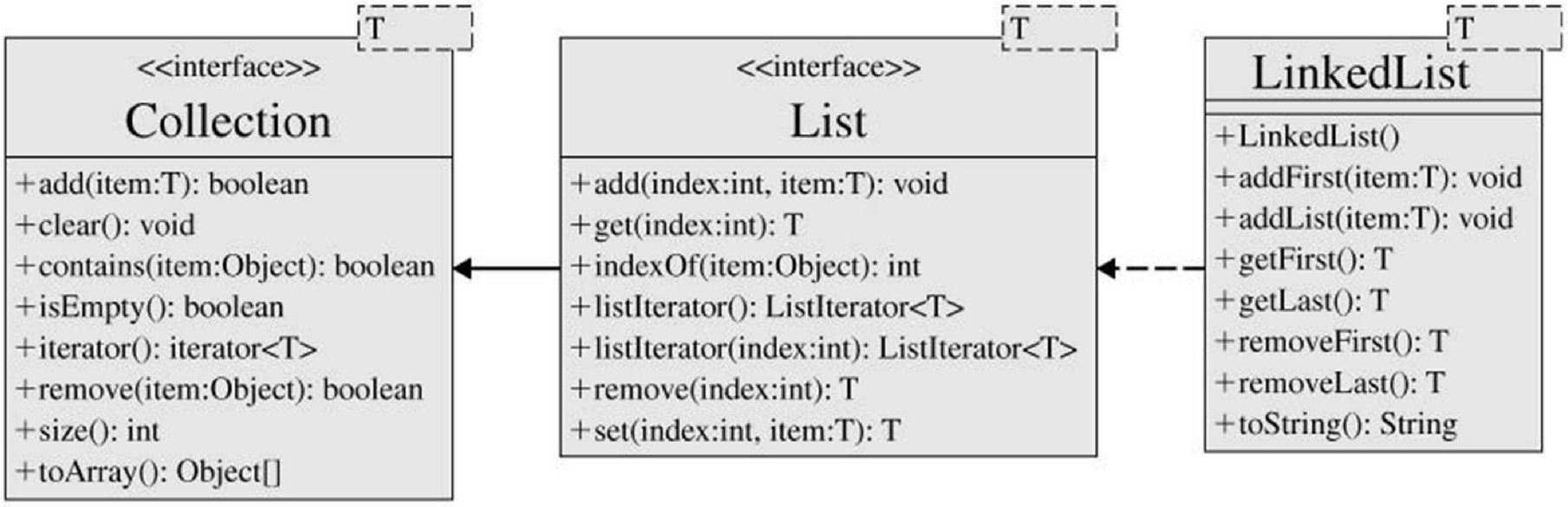
Accessing the Ends of a LinkedList

- A series of O(1) operations access and update the elements at the ends of the list.
- For the front of the list, the class defines the methods getFirst(), addFirst(), and removeFirst().
- The counterparts at the back of the list are getLast(), addLast(), and removeLast().

Accessing the Ends of a LinkedList (concluded)

- A linked list is a natural storage structure for implementing a queue. The element at the front (getFirst()) is the one that exits (removeFirst()) the queue. A new element enters (addLast()) at the back of the queue.

UML for the LinkedList Class

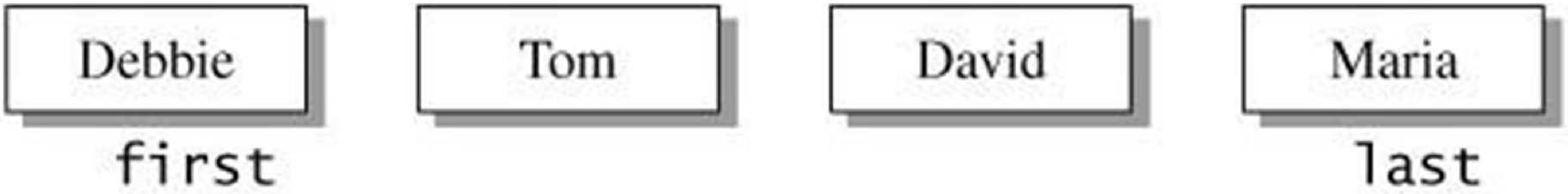


End-of-List Methods Example

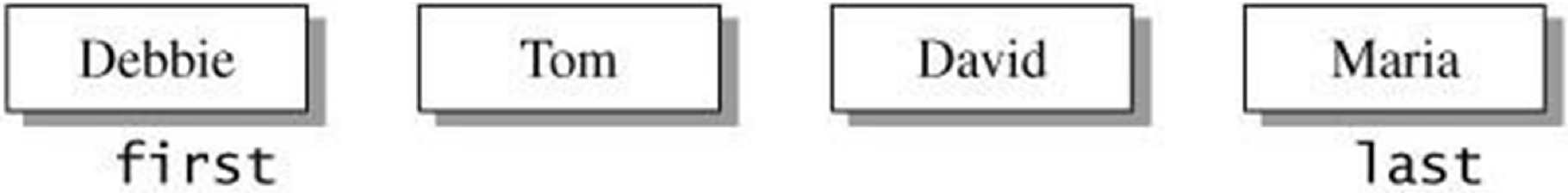
The "add" methods build the list by adding a new element. Observe that successive calls to addFirst() inserts elements in reverse order; successive calls to addLast() inserts the elements in the normal order.

```
list.addFirst("Tom");
list.addFirst("Debbie");

list.addLast("David");
ist.addLast("Maria");
```



End-of-List Methods Example (continued)



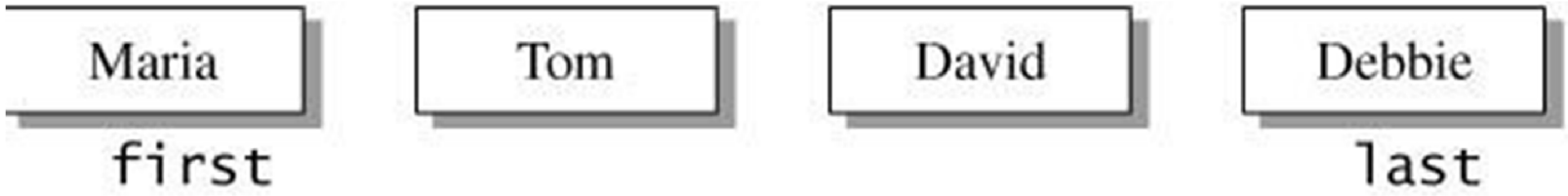

```
// identify the elements at the ends of the list
System.out.println("First element is " + list.getFirst());
System.out.println("Last element is " + list.getLast());
```

```
Output:   First element is Debbie
          Last element is Maria
```

End-of-List Methods Example (continued)

Exchange the first and last elements in the list.

```
String firstElement, lastElement;
// remove the elements at the ends of the list and capture
// their values
firstElement = aList.removeFirst();
lastElement = aList.removeLast();
// add the elements back into the list with firstElement
// at the back and lastElement at the front
aList.addLast(firstElement);
aList.addFirst(lastElement);
```



End-of-List Methods Example (concluded)

Output the elements in the list by position. Repeatedly delete the first element and display its value until the list is empty.

```
while (!aList.isEmpty())
   System.out.print(aList.removeFirst() + "  ");
```

```
Output:
   Maria  Tom  David  Debbie
```

Program 10.2

```
import ds.util.LinkedList;
import java.util.Scanner;

public class Program10_2
{
   public static void main(String[] args)
   {
      // create an empty linked list
      LinkedList<String> draftlist =
         new LinkedList<String>();

      // variables used to update the draft list
      int fromIndex, toIndex;
      char updateAction;
      String playerName;
      String obj;
```

Program 10.2 (continued)

```
// initial names in the list and the
// keyboard input file
String[] playerArr ={"Jones", "Hardy",
   "Donovan", "Bundy"};
Scanner keyIn = new Scanner(System.in);
String inputStr;

// initialize the list
for (int i = 0; i < playerArr.length; i++)
   draftlist.add(playerArr[i]);

// give instructions on updating the list
System.out.println("Add player:    " +
   "Input 'a' <name>");
System.out.println("Shift player:  " +
   "Input 's' <from> <to>");
System.out.println("Delete player: " +
   "Input 'r' <name>" + "\n");
```

Program 10.2 (continued)

```
// initial list
System.out.println("List: " + draftlist);

// loop executes the simulation of draft updates
while (true)
{
   // input updateAction, exiting on 'q'
   System.out.print("   Update: ");
   updateAction = keyIn.next().charAt(0);

   if (updateAction == 'q')
      break;

   // execute the update
   switch(updateAction)
   {
```

Program 10.2 (continued)

```
case 'a':
   // input the name and add to end of list
   playerName = keyIn.next();
   draftlist.add(playerName);
   break;

case 'r':
   // input the name and remove from list
   playerName = keyIn.next();
   draftlist.remove(playerName);
   break;

case 's':
   // input two indices to shift an
   // element from a source position
   // to a destination position;
   // remove element at source and
   // add at destination
   fromIndex = keyIn.nextInt();
```

Program 10.2 (concluded)

```
                // set to list position
                fromIndex--;
                toIndex = keyIn.nextInt();
                // set to list position
                toIndex--;
                obj = draftlist.remove(fromIndex);
                draftlist.add(toIndex, obj);
                break;
            }
            // Display status of current draft list
            System.out.println("List: " + draftlist);
        }
    }
}
```

Program 10.2 (Run)

```
Run:

Add player:    Input 'a' <name>
Shift player:  Input 's' <from> <to>
Delete player: Input 'r' <name>

List: [Jones, Hardy, Donovan, Bundy]
   Update: a Harrison
List: [Jones, Hardy, Donovan, Bundy, Harrison]
   Update: s 4 2
List: [Jones, Bundy, Hardy, Donovan, Harrison]
   Update: r Donovan
List: [Jones, Bundy, Hardy, Harrison]
   Update: a Garcia
List: [Jones, Bundy, Hardy, Harrison, Garcia]
   Update: s 5 2
List: [Jones, Garcia, Bundy, Hardy, Harrison]
   Update: s 1 4
List: [Garcia, Bundy, Hardy, Jones, Harrison]
   Update: q
```

Palindromes

- A palindrome is a sequence of values that reads the same forward and backward. "level" is a palindrome.
- The method, isPalindrome(), takes a LinkedList object as an argument and returns the boolean value true if the sequence of elements is a palindrome and false otherwise.
- The algorithm compares the elements on opposite ends of the list, using getFirst() and getLast().

isPalindrome()

In the implementation of isPalindrome(), the return type does not depend on a named generic type (return type is boolean). Likewise, the parameter list does not require a named generic type. In this situation, we use a wildcard in the method signature. The syntax

```
LinkedList<?> aList
```

means that aList is a LinkedList object whose elements are of unknown type.

isPalindrome() (concluded)

```
public static boolean isPalindrome(LinkedList<?> aList)
{
   // check values at ends of list as
   // long as list size > 1
   while (aList.size() > 1)
   {
      // compare values on opposite ends; if not equal,
      // return false
      if (aList.getFirst().equals(aList.getLast())
            == false)
         return false;

      // delete the objects
      aList.removeFirst();
      aList.removeLast();
   }

   // if still have not returned, list is a palindrome
   return true;
}
```

Program 10.3

```
import ds.util.LinkedList;
import java.util.Scanner;

public class Program10_3
{
   public static void main(String[] args)
   {
      String str;
      LinkedList<Character> charList =
         new LinkedList<Character>();
      Scanner keyIn = new Scanner(System.in);
      int i;
      char ch;

      // prompt user to enter a string
      // that may include blanks and
      // punctuation marks
      System.out.print("Enter the string: ");
      str = keyIn.nextLine();
```

Program 10.3 (continued)

```
// copy all of the letters as
// lowercase characters to the
// linked list charList
for (i = 0; i < str.length(); i++)
{
   ch = str.charAt(i);

   if (Character.isLetter(ch))
      charList.addLast(Character.toLowerCase(ch));
}

// call isPalindrome() and use return
// value to designate whether the string
// is or is not a palindrome
if (isPalindrome(charList))
   System.out.println("'" + str +
                      "' is a palindrome");
```

Program 10.3 (concluded)

```
        else
            System.out.println("'" + str +
                                "' is not a palindrome");
    }

    < Code for method isPalindrome() >
}
```

```
Run 1:
Enter the string: A man, a plan, a canal, Panama
'A man, a plan, a canal, Panama' is a palindrome

Run 2:
Enter the string: Go hang a salami, I'm a lasagna hog
'Go hang a salami, I'm a lasagna hog' is a palindrome

Run 3:
Enter the string: palindrome
'palindrome' is not a palindrome
```