Cache List

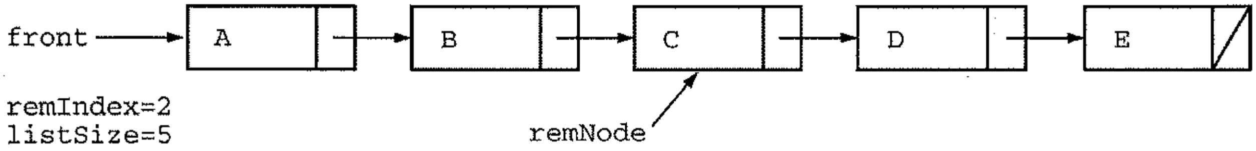
2. Suppose `myList` is a linked list. A loop such as

```
for (int k = 0; k < myList.size(); k++)
  Object a = myList.get(k);
```

can be inefficient if the `get` method always starts at the front of the list to locate each element.

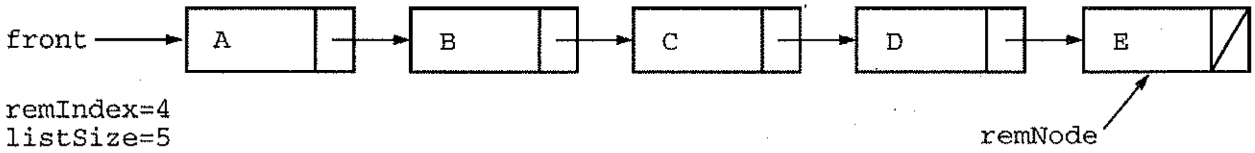
This question describes a variant of a linked list data structure that can improve the efficiency of the loop. The `ListNode` class is used as part of the implementation of a class `APList` that remembers the node and index of the most recently visited element of the list. If the index for the next `get` is greater than or equal to the remembered index, the traversal starts at the remembered node instead of the front of the list.

For example, consider the following `APList myList` that contains five elements. The call `myList.get(2)` returns the value C. The remembered node and remembered index will refer to the node at index 2 as shown in the diagram.

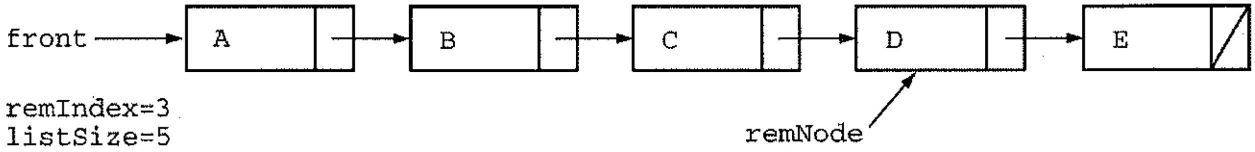


If the call `myList.get(2)` is executed again, the value C is returned again, but the traversal begins at the `remNode` position, instead of `front`, because the remembered index is 2. No other nodes are traversed because `remNode` is already at the correct position.

A subsequent call `myList.get(4)` will start the traversal at the `remNode` position instead of `front` because the remembered index is 2. It will then move forward two nodes to retrieve the node at index 4 (the value E), set `remNode` to the new position, and update `remIndex` as shown in the following diagram.



Finally, a subsequent call `myList.get(3)` will start the traversal at `front` because the remembered index is greater than the desired index. Starting at `front`, it will move forward three nodes to retrieve the node at index 3 (the value D), set `remNode` to the new position, and update `remIndex` as shown in the following diagram.



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The partial declaration of the `APList` class is shown below.

```
public class APList
{
  private ListNode front;     // first node of this list (null if empty)

  private int listSize;       // the number of elements in this list

  private int remIndex;       // the index of the remembered node

  private ListNode remNode;   // a reference to the node accessed by most recent call to get


  /** Constructs an empty APList.
   */
  public APList()
  {
    front = null;
    remIndex = -1;
    remNode = null;
    listSize = 0;
  }


  /** Gets a value at a given index in this list.
   *  @param n  the index at which to get a value
   *            Precondition: 0 ≤ n < size()
   *  @return  the object at the given index
   *  Postcondition: The remembered node and index refer to the node at index n
   */
  public Object get(int n)
  {  /* to be implemented in part (a) */ }


  /** Adds a new node containing obj to the front of this list.
   *  @param obj  the value to add to the list
   */
  public void addFirst(Object obj)
  {  /* to be implemented in part (b) */  }


  /** @return  the size of this list
   */
  public int size()
  { return listSize; }

  // There may be methods that are not shown.
}
```

(a) Write the APList method get. This method returns the value contained in the list node at index n. If the index n is greater than or equal to the remembered index, the method should start its traversal at the remembered node; otherwise, the method should start at the front of the list. The remembered node and index should be updated to refer to the node at the given index.

Complete method get below.

```
/** Gets a value at a given index in this list.
 *  @param n  the index at which to get a value
 *            Precondition: 0 ≤ n < size()
 *  @return  the object at the given index
 *  Postcondition: The remembered node and index refer to the node at index  n
 */
public Object get(int n)
```

(b) Write the APList method addFirst. Instance variables should be updated as necessary. This method should not change the value of remNode since there is no advantage to remembering a node at the front of the list.

Complete method addFirst below.

```
/** Adds a new node containing obj to the front of this list.
 *  @param obj  the value to add to the list
 */
public void addFirst(Object obj)
```

(c) Consider the following methods.

```
public static void printForward(SomeListType myList)
{
  int n = myList.size();
  for (int k = 0; k < n; k++)
  {
    Object obj = myList.get(k);
    System.out.println(obj);
  }
}
```

```
public static void printReverse(SomeListType myList)
{
  int n = myList.size();
  for (int k = n - 1; k >= 0; k--)
  {
    Object obj = myList.get(k);
    System.out.println(obj);
  }
}
```

Give the big-Oh running time (in terms of *n*) of these methods for the following list types, where *n* is the number of elements in the list.

SomeListType	printForward	printReverse
LinkedList<Object>		
APList		

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