

COMP 250

INTRODUCTION TO COMPUTER SCIENCE

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Week 5-2 : Singly Linked Lists

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Giulia Alberini, Fall 2020

WHAT ARE WE GOING TO DO IN THIS VIDEO?



- Singly Linked Lists Assignment Project Exam Help

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LINKED LISTS
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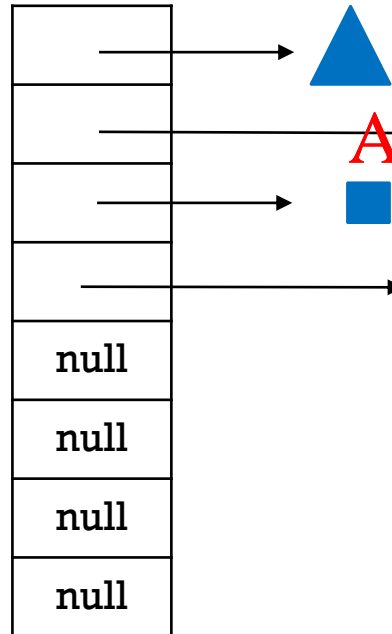
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IMPLEMENTATIONS

There are different implementations of a list:

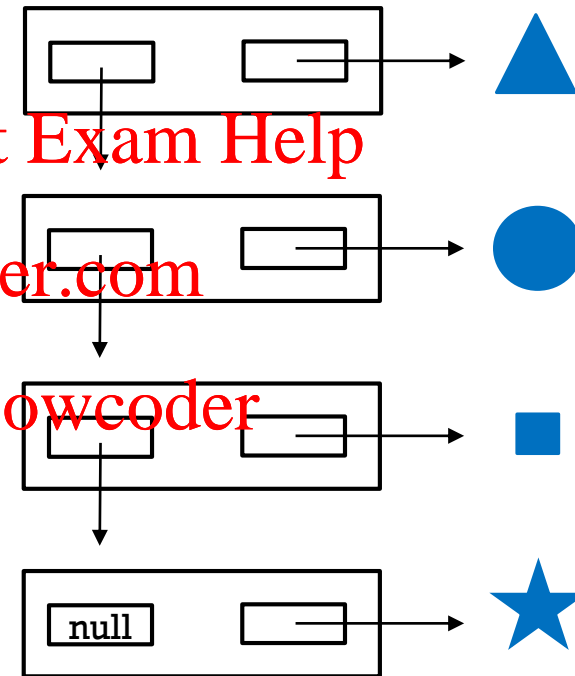
- Array list
 - Singly linked list
 - Doubly linked list
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- Idea: the elements in the list are linked using pointers

Array list



Linked list

“nodes”



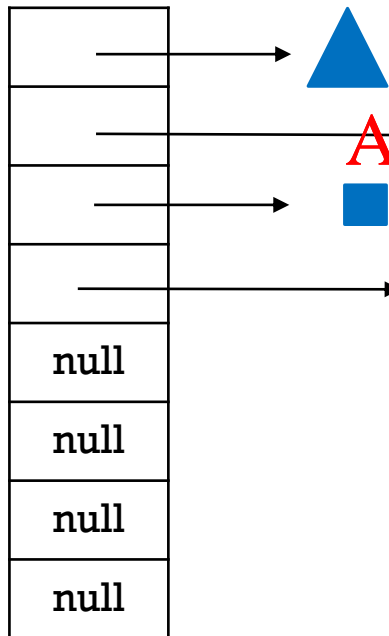
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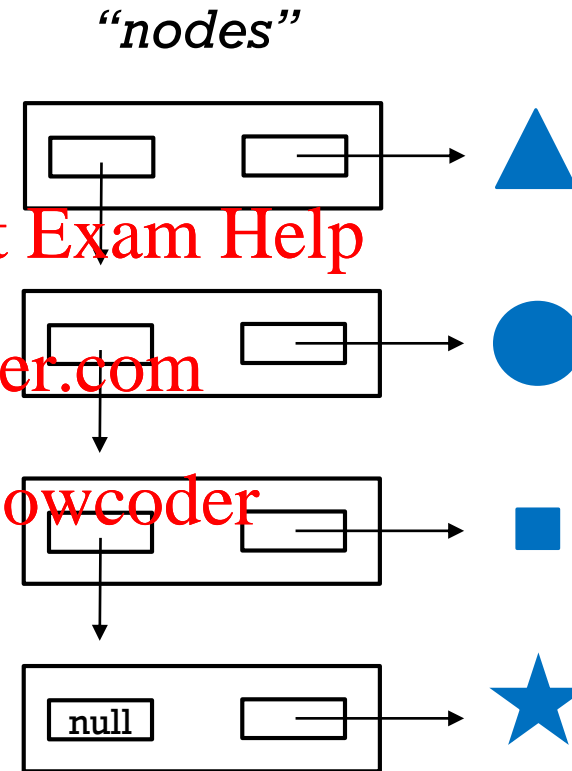
size = 4

Array list



Array slots are in consecutive locations (addresses) in memory, but objects (elements) can be anywhere.

Linked list



Linked list “nodes” and objects (elements) can be anywhere in memory.

SINGLY LINKED LIST NODE

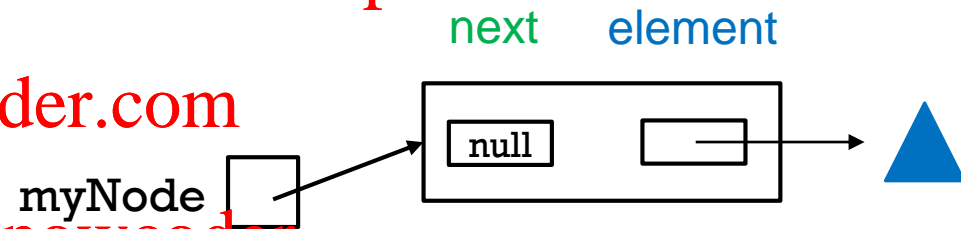
```
class SNode {  
    Shape element;  
    SNode next;  
}
```

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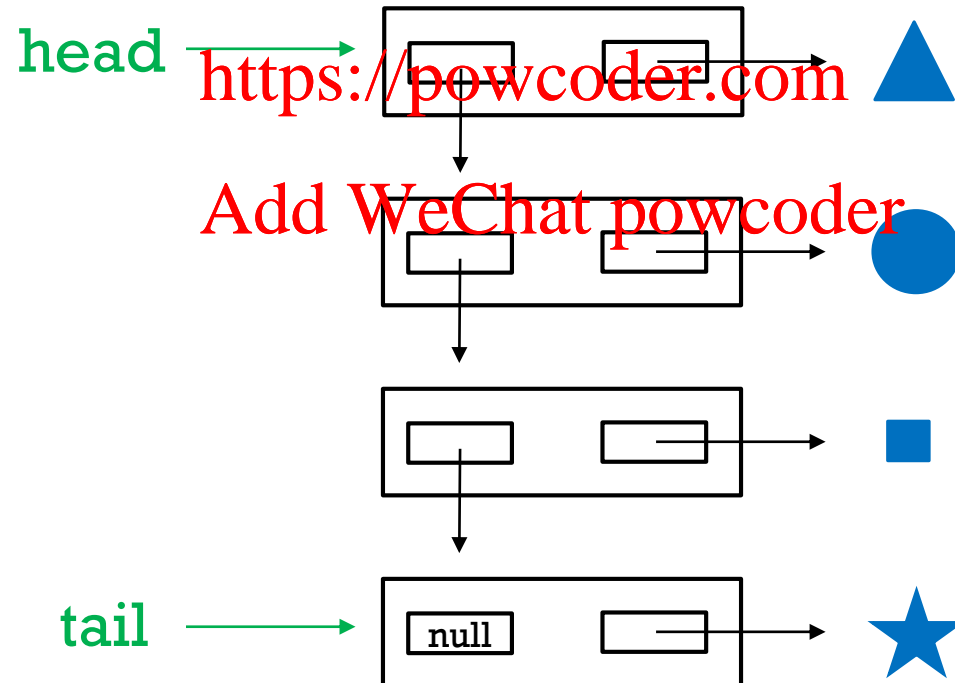
```
SNode myNode = new SNode();  
n.element = new Shape(▲);
```



SINGLY LINKED LIST

We think of a linked list as a sequence of nodes, along with a reference to the first (**head**) and last (**tail**) node.

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SINGLY LINKED LIST

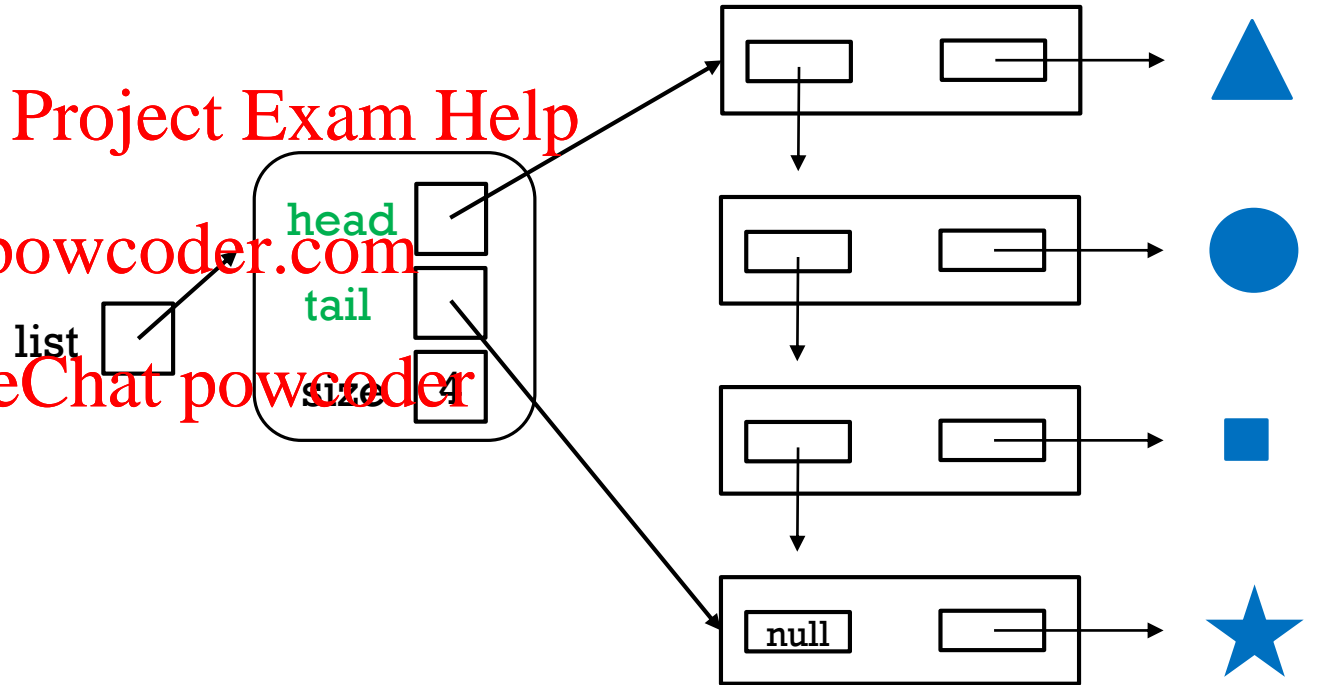
```
public class SLinkedList {  
    private SNode head;  
    private SNode tail;  
    private int size;  
    :  
    private class SNode {  
        Shape element;  
        SNode next;  
    }  
}
```

```
SLinkedList list = new SLinkedList();  
:
```

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LINKED LIST OPERATIONS

- `addFirst (e)`
- `removeFirst()`
- `addLast (e)`
- `removeLast()`
-many other list operations

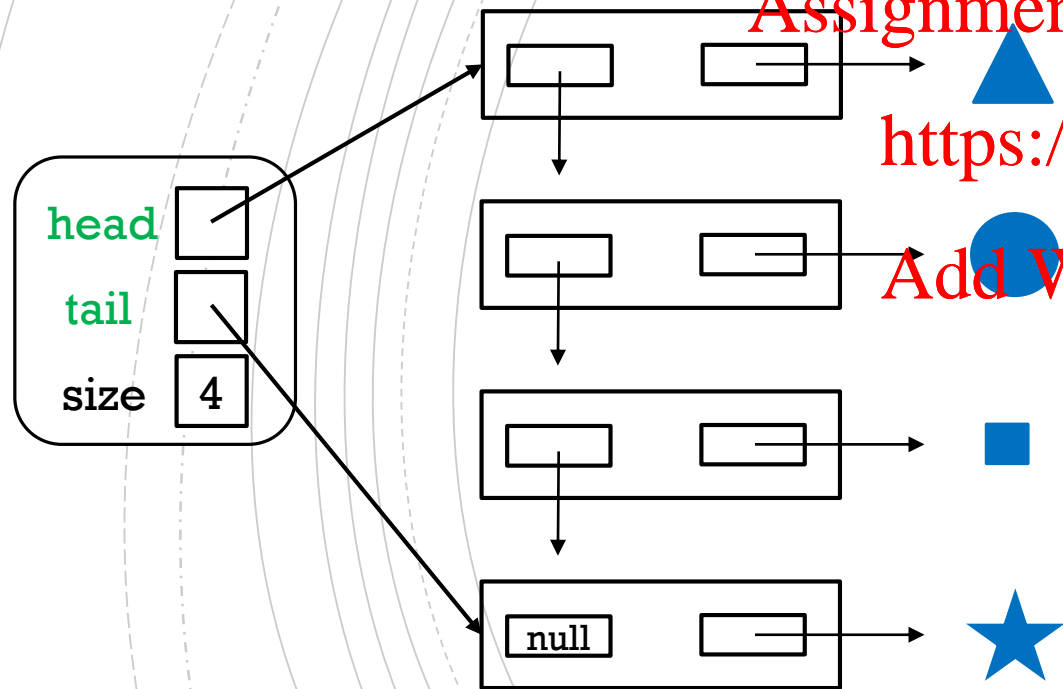
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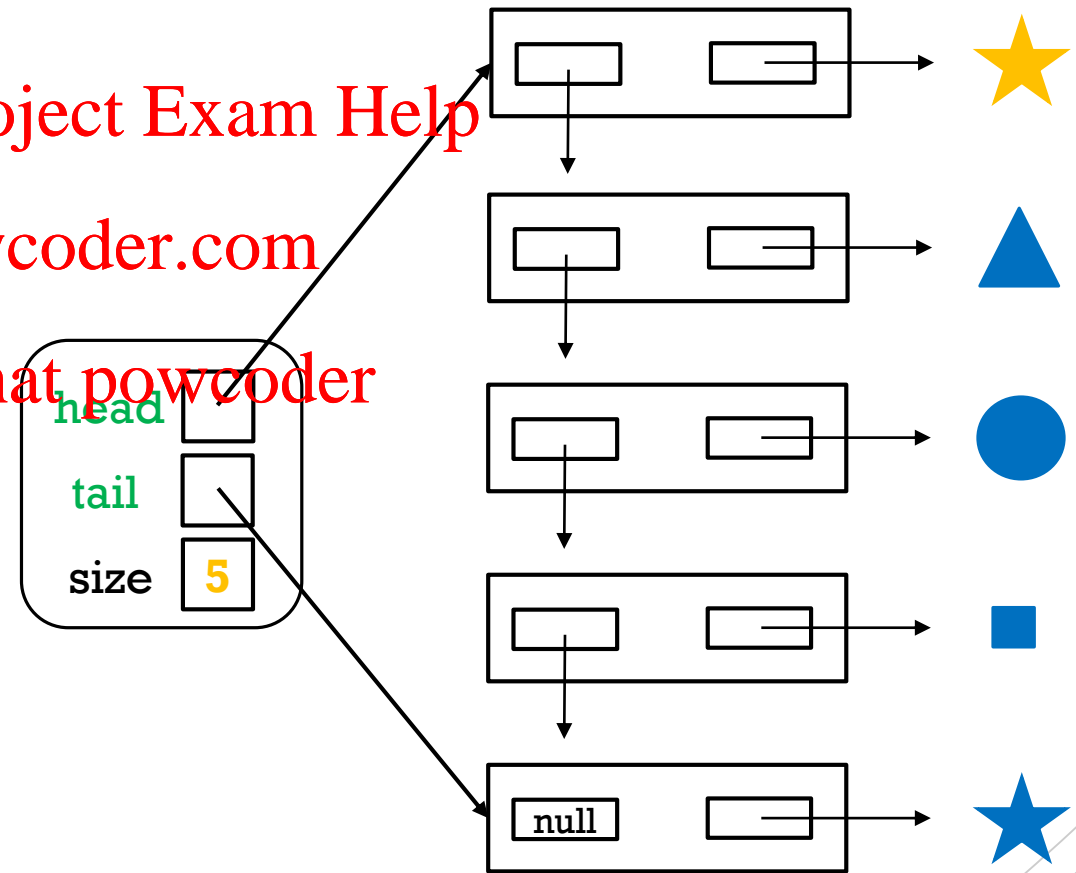
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LINKED LIST OPERATIONS – addFirst(★)

BEFORE



AFTER



addFirst(e) – PSEUDOCODE

```
SNode newNode = new SNode();
```

```
newNode.element = e;
```

```
newNode.next = head;
```

```
// edge case
```

```
if (head == null)
```

```
    tail = newNode;
```

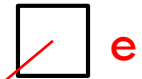
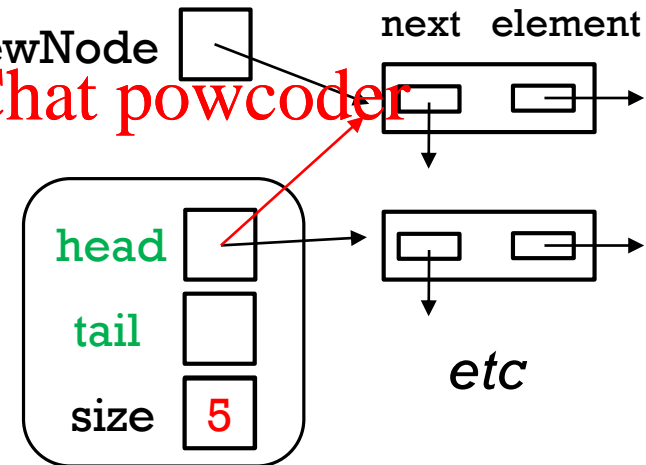
```
head = newNode;
```

```
size = size + 1;
```

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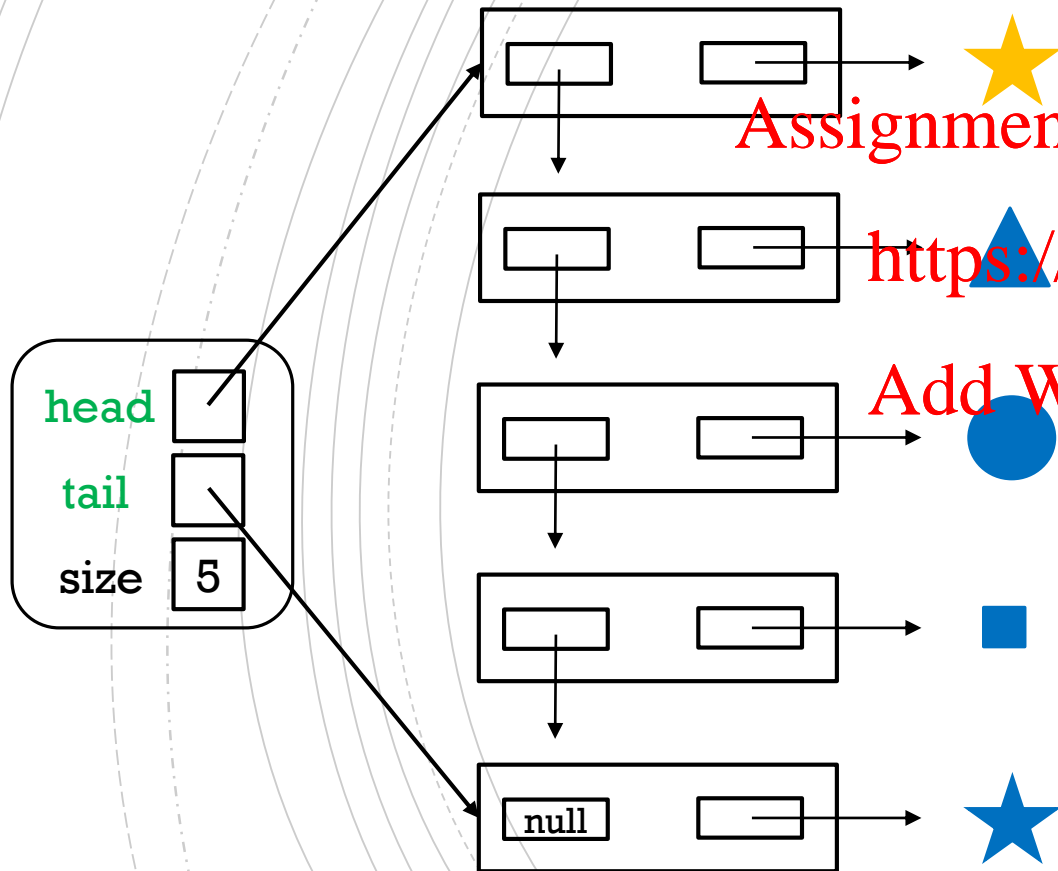
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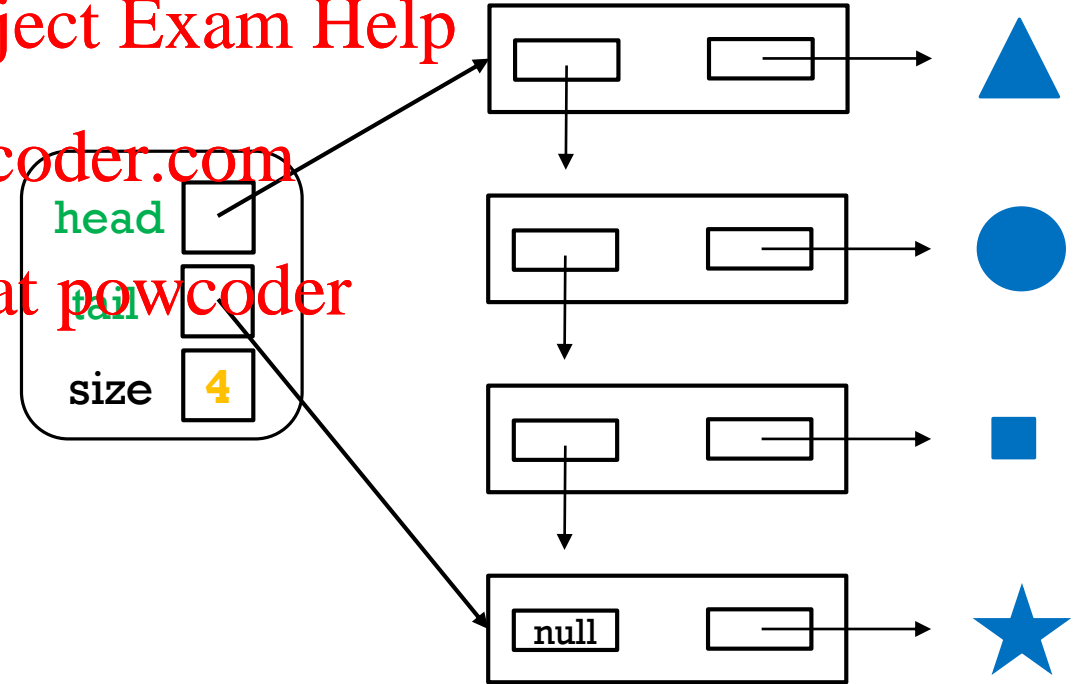


LINKED LIST OPERATIONS – removeFirst()

BEFORE



AFTER



removeFirst() – PSEUDOCODE

```
SNode temp = head;  
head = temp.next;  
temp.next = null; // not required  
size = size - 1;  
return temp.element;
```

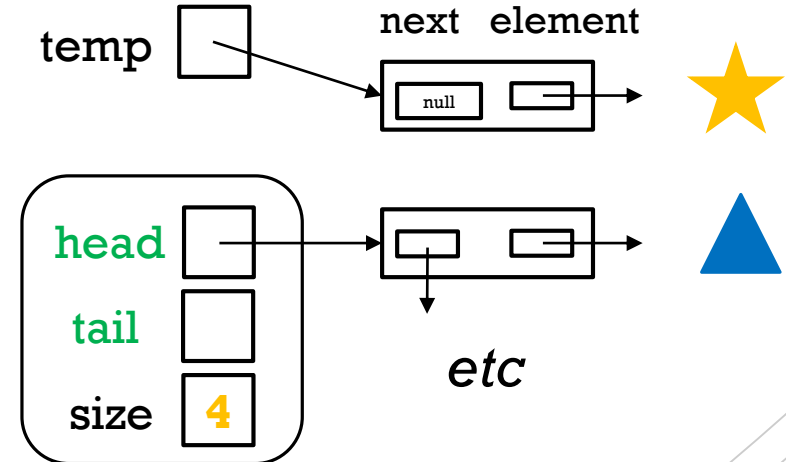
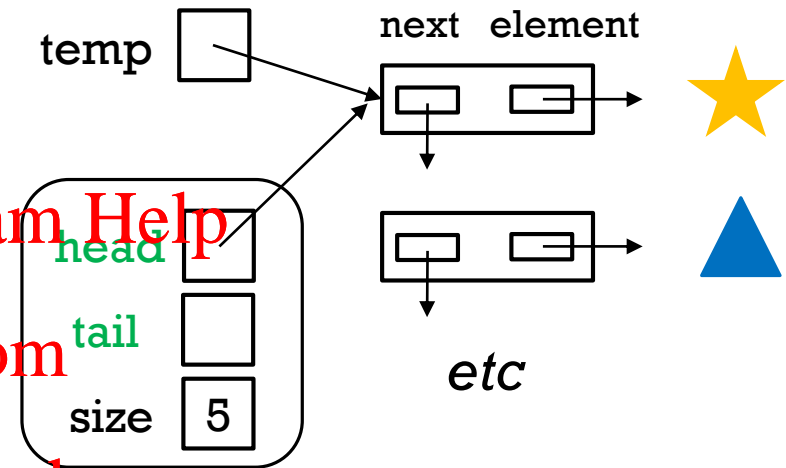
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BEFORE

AFTER



removeFirst() – EDGE CASES (SIZE IS 0 OR 1)

```
SNode temp = head;
```

```
if (size == 0)
```

```
    throw exception
```

```
head = temp.next;
```

```
temp.next = null;
```

```
size = size - 1;
```

```
if (size == 0)
```

```
    tail = null;
```

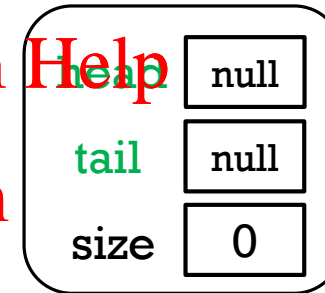
```
return temp.element;
```

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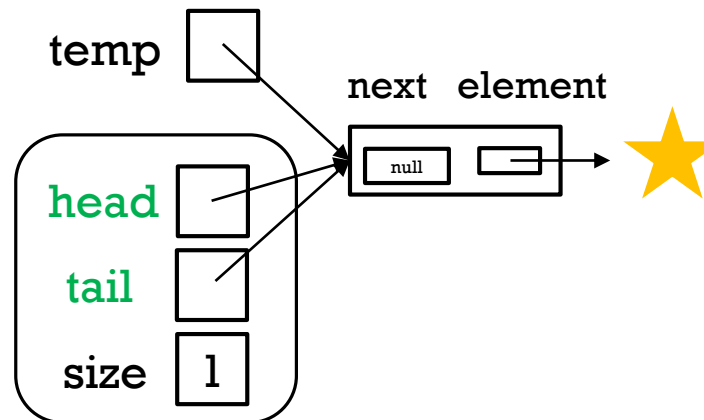
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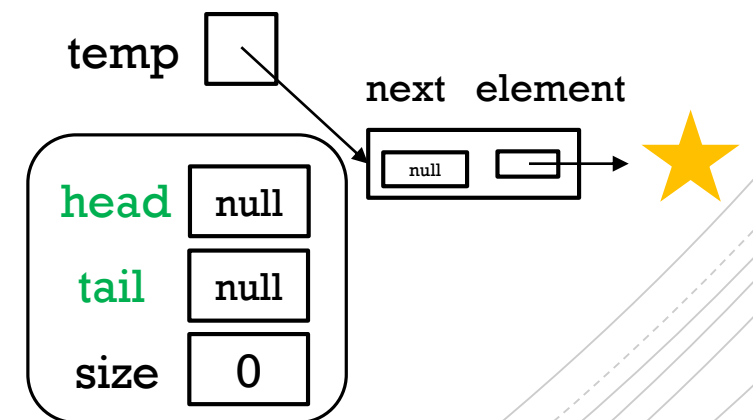
temp null



Size = 0
Size = 1



Before After



WORSE CASE TIME COMPLEXITY (N = LIST SIZE)

| | array list | linked list |
|---------------|------------|-------------|
| addFirst() | $O(N)$ | $O(1)$ |
| removeFirst() | $O(N)$ | $O(1)$ |

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For arraylist with N elements,
recall that add(0, e) and remove(0)
required a loop with N iterations

For linked lists the implementation
of addFirst() and removeFirst()
does not depend on the number of
elements in the list

WORSE CASE TIME COMPLEXITY (N = LIST SIZE)

| | array list | linked list |
|---------------|------------|-------------|
| addFirst() | $O(N)$ | $O(1)$ |
| removeFirst() | $O(N)$ | $O(1)$ |
| addLast() | $O(1)^*$ | ? |
| removeLast() | $O(1)$ | ? |

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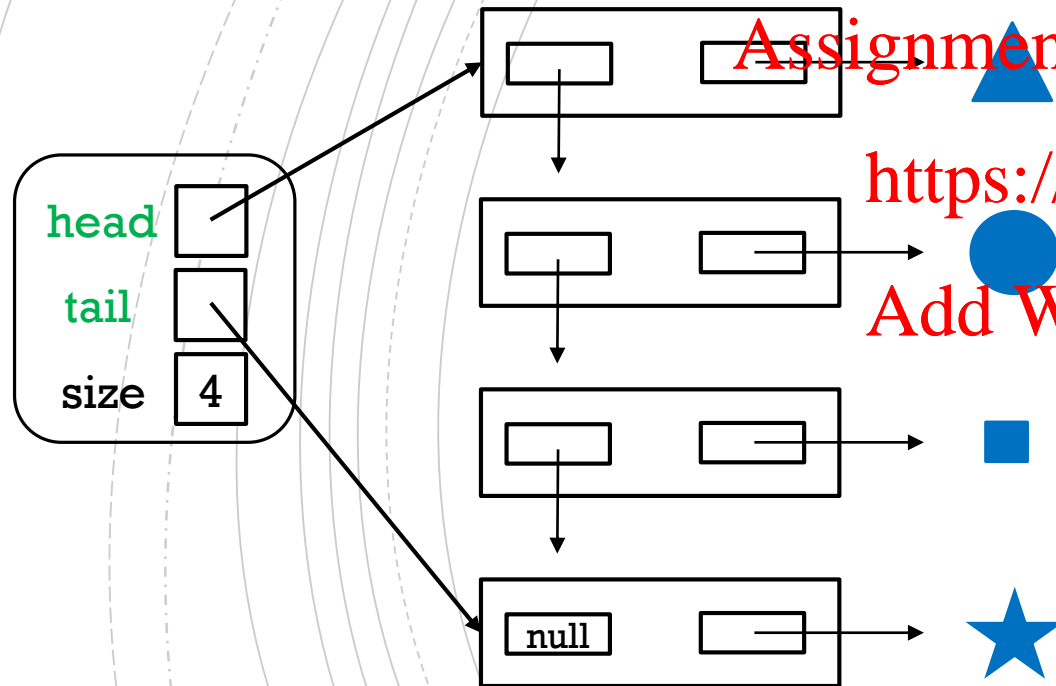
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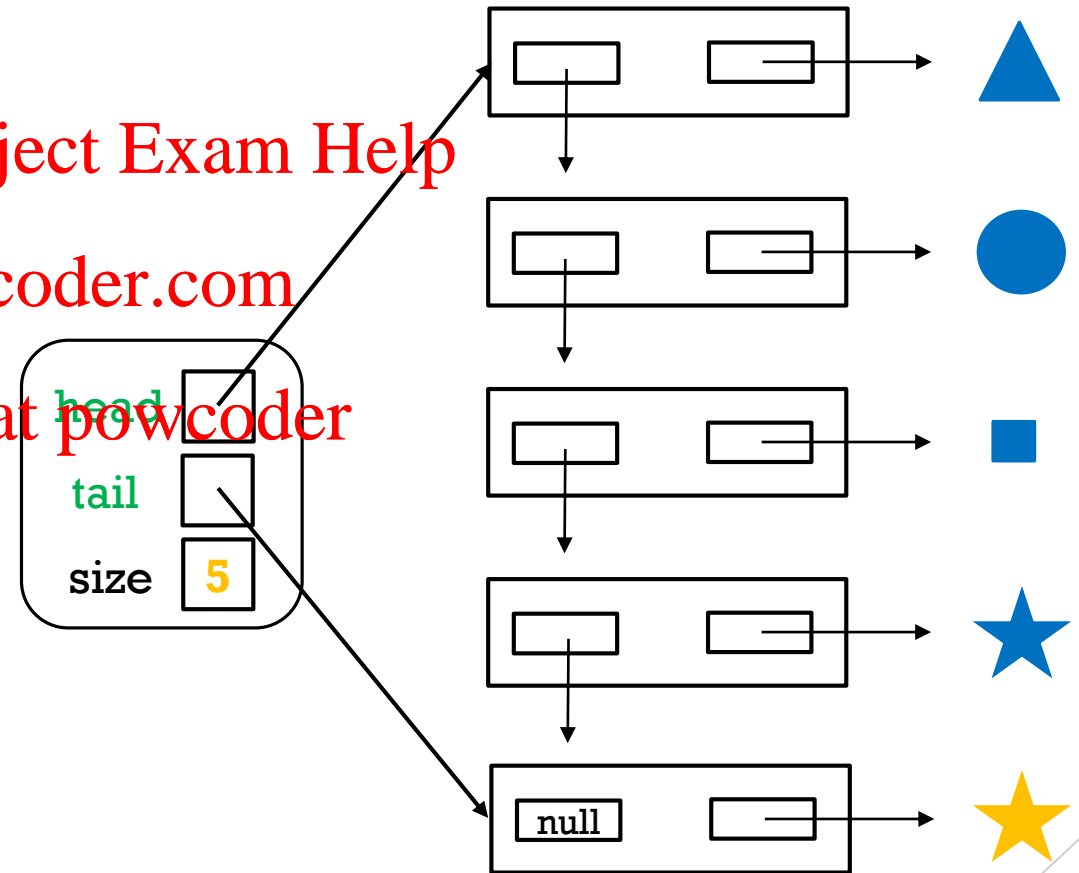
*if array is not full

LINKED LIST OPERATIONS – addLast(★)

BEFORE



AFTER



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addLast (e) – PSEUDOCODE

```
// create a new node
```

```
SNode newNode = new SNode();
```

```
newNode.element = e;
```

```
// add it at the end
```

```
tail.next = newNode;
```

```
tail = tail.next;
```

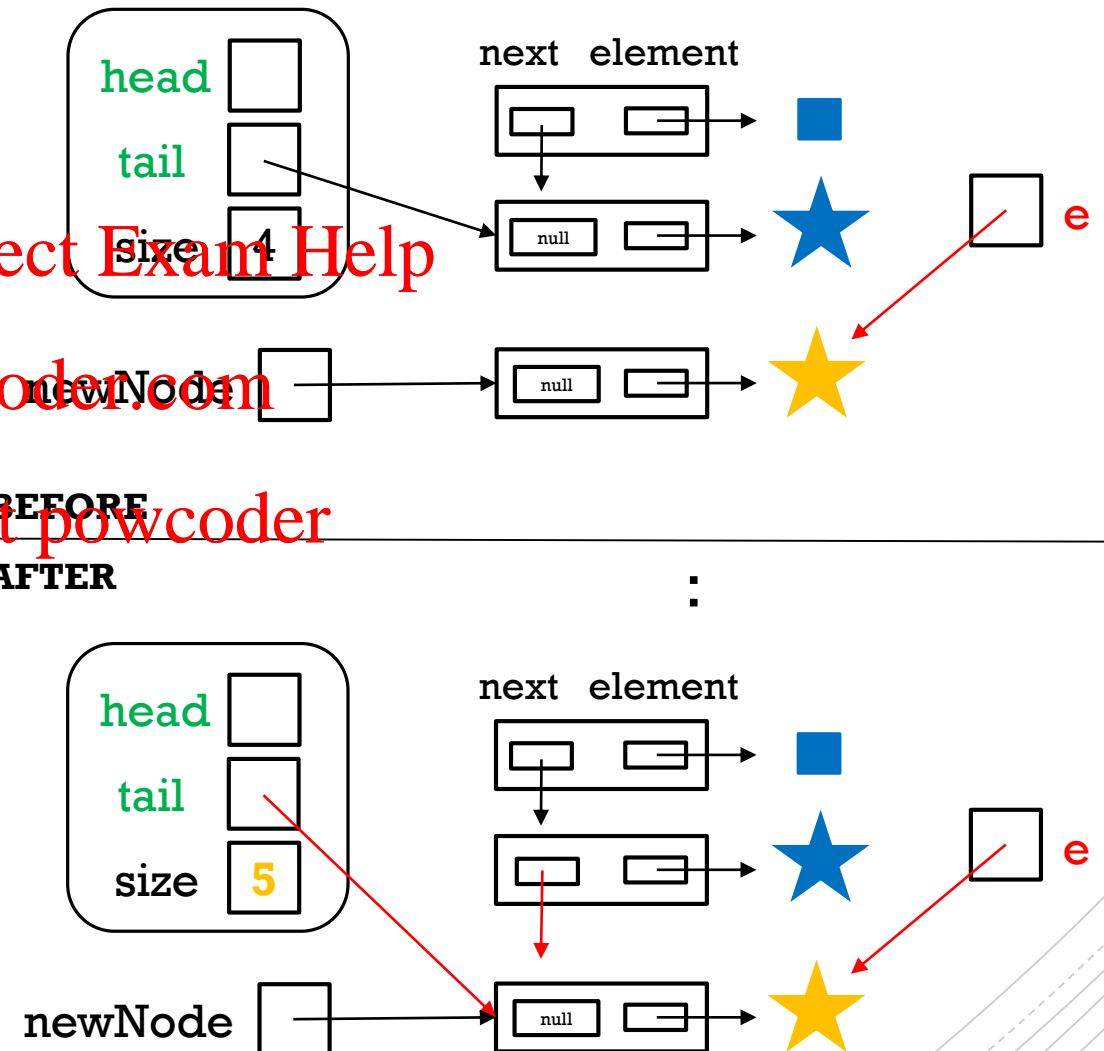
```
size = size + 1;
```

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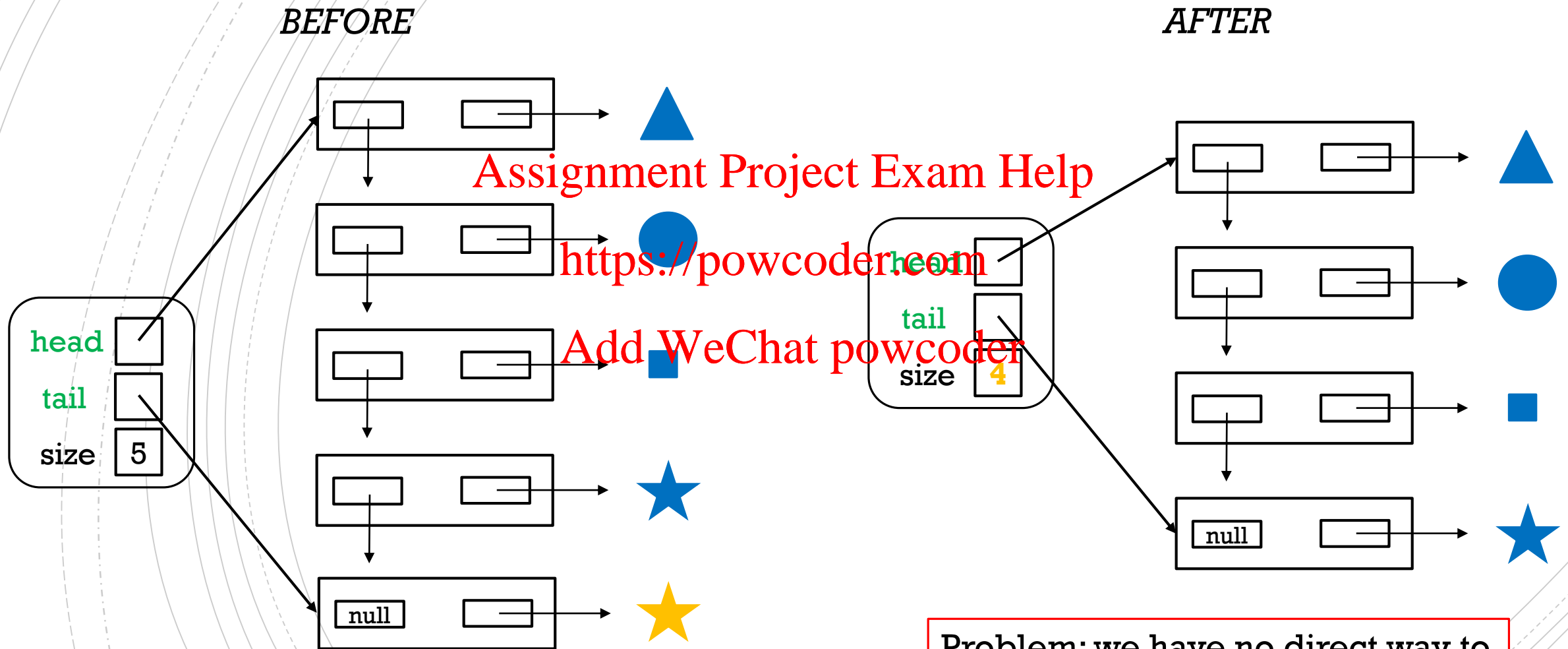
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BEFORE
AFTER



LINKED LIST OPERATIONS – removeLast()



Problem: we have no direct way to access the node before tail!

removeLast() – PSEUDOCODE

```
SNode tmp = head;
```

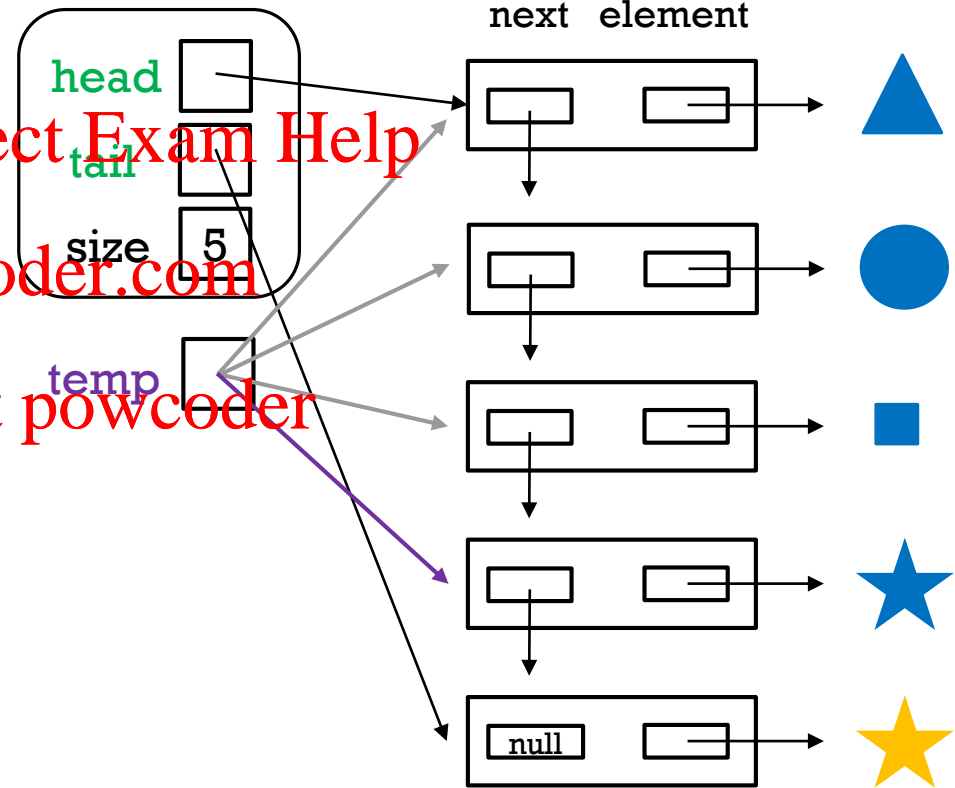
```
while (tmp.next != tail)
```

```
tmp = tmp.next;
```

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removeLast() – PSEUDOCODE

```
SNode tmp = head;
```

```
while (tmp.next != tail)
```

```
    tmp = tmp.next;
```

```
tail = tmp;
```

```
tail.next = null;
```

```
size = size - 1;
```

```
// to return the element,
```

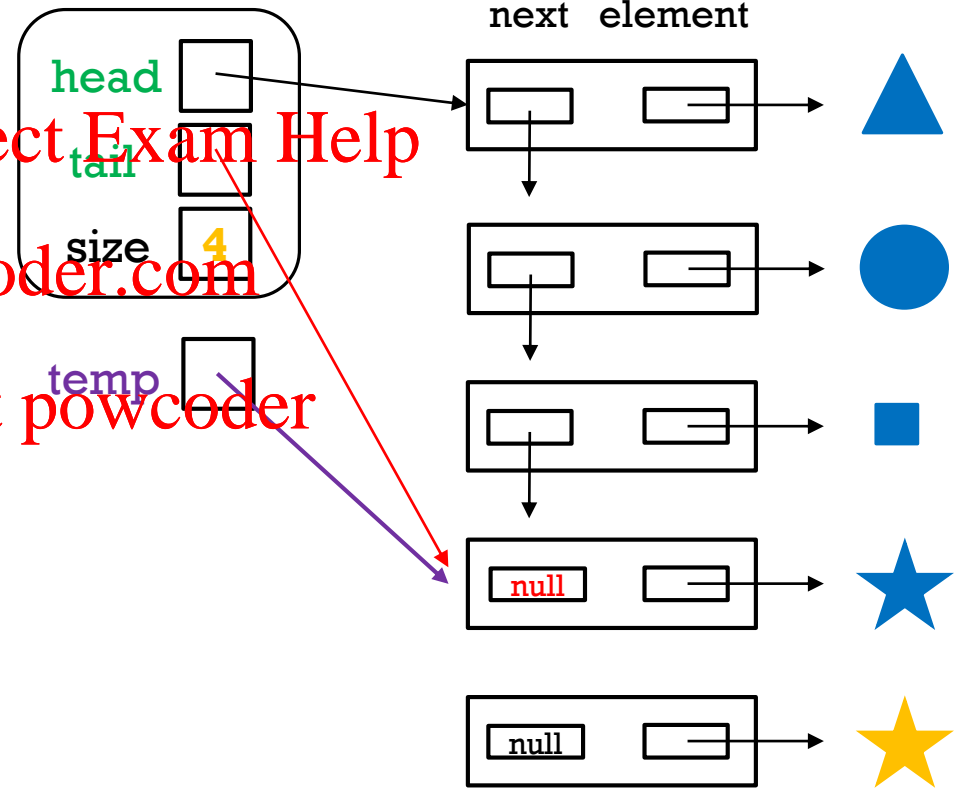
```
// you need to do a bit more work
```

```
// edge cases for size = 0 and 1 to be added
```

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removeLast () – EDGE CASES (SIZE IS 0 OR 1)

```
if (size == 0)
```

```
    throw exception
```

```
if (size == 1)
```

```
    head = null;
```

```
    tail = null;
```

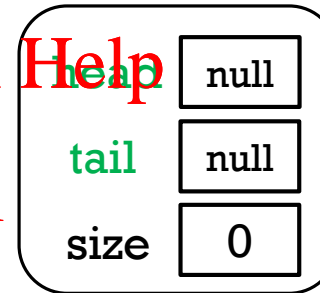
```
else {
```

```
    ...
```

```
}
```

```
size = size - 1;
```

temp null



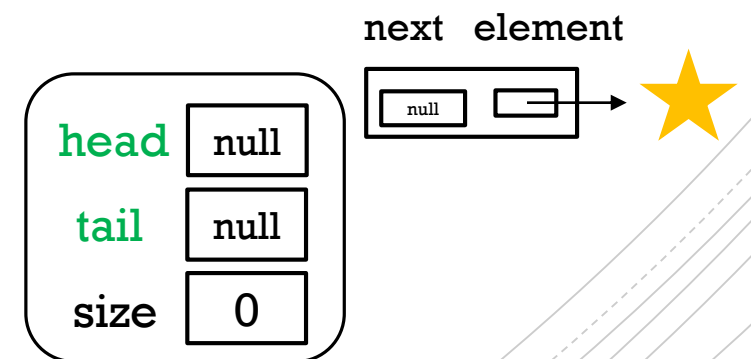
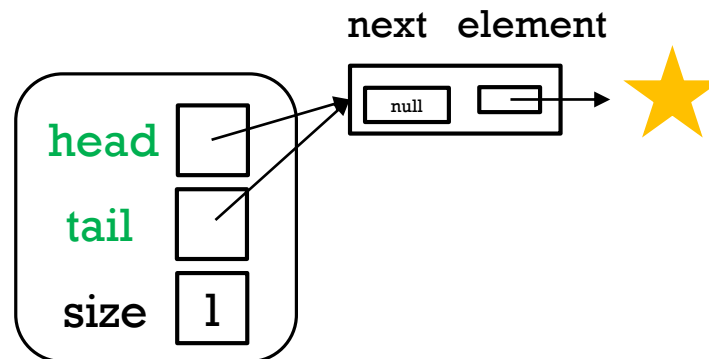
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Size = 0
Size = 1

Before

After



WORSE CASE TIME COMPLEXITY (N = LIST SIZE)

| | array list | linked list |
|---------------|------------|-------------|
| addFirst() | $O(N)$ | $O(1)$ |
| removeFirst() | $O(N)$ | $O(1)$ |
| addLast() | $O(1)^*$ | $O(1)$ |
| removeLast() | $O(1)$ | $O(N)$ |

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*if array is not full



Coming Soon

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