

```
1 List<Integer> list1 = new ArrayList<Integer>();
2 list1.add(8);
3 list1.add(3);
4 List<Integer> list2 = new ArrayList<Integer>();
5 list2.add(100);
6 List<Integer> list3 = list2;
7 list2 = list1;
8 list2.add(5);
9 list1.add(2);
10 System.out.println("A: " + list1);
11 System.out.println("B: " + list2);
12 System.out.println("C: " + list3);
```

What does this code print? Write your answer in L11.

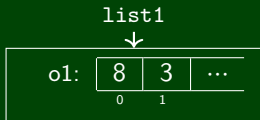
```
1 List<Integer> list1 = new ArrayList<Integer>();
2 list1.add(8);
3 list1.add(3);
4 List<Integer> list2 = new ArrayList<Integer>();
5 list2.add(100);
6 List<Integer> list3 = list2;
7 list2 = list1;
8 list2.add(5);
9 list1.add(2);
10 System.out.println("A: " + list1);
11 System.out.println("B: " + list2);
12 System.out.println("C: " + list3);
```

What does this code print? Write your answer in L11.

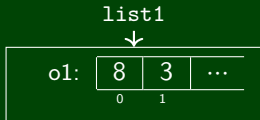
OUTPUT

```
>> A: [8, 3, 5, 2]
>> B: [8, 3, 5, 2]
>> C: [100]
```

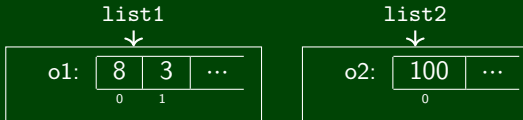
```
1 List<Integer> list1 = new ArrayList<Integer>(); //o1
2 list1.add(8);
3 list1.add(3);
```



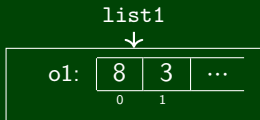
```
1 List<Integer> list1 = new ArrayList<Integer>(); //o1
2 list1.add(8);
3 list1.add(3);
```



```
4 List<Integer> list2 = new ArrayList<Integer>(); //o2
5 list2.add(100);
```



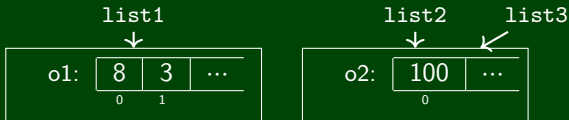
```
1 List<Integer> list1 = new ArrayList<Integer>(); //o1
2 list1.add(8);
3 list1.add(3);
```



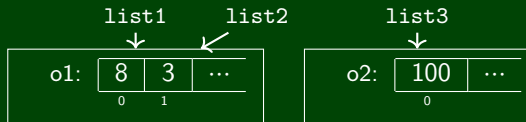
```
4 List<Integer> list2 = new ArrayList<Integer>(); //o2
5 list2.add(100);
```



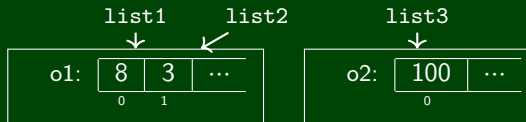
```
6 List<Integer> list3 = list2;
```



```
7 list2 = list1;
```

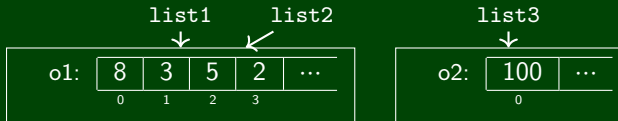


```
7 list2 = list1;
```

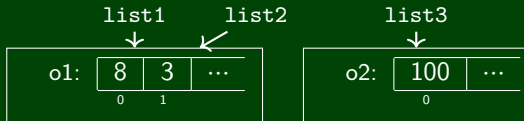


```
8 list2.add(5);
```

```
9 list1.add(2);
```

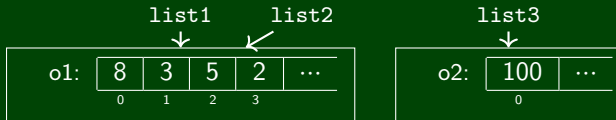


```
7 list2 = list1;
```



```
8 list2.add(5);
```

```
9 list1.add(2);
```



What's Going On?

- The keyword **new** creates an actual new object to point to (o1, o2).
- All the other variables just point to objects that were created with new (list1, list2, list3).

ListNode Class

```
1 public class ListNode {  
2     int data;  
3     ListNode next;  
4 }
```

A ListNode is:



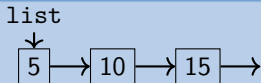
The **box** represents data, and the **arrow** represents next.

Since next is of ListNode type, the arrow can either point to nothing (null) or another ListNode.

ListNode Class

```
1 public class ListNode {  
2     int data;  
3     ListNode next;  
4 }
```

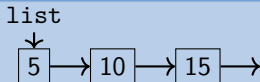
How can we use code to make this list?



ListNode Class

```
1 public class ListNode {  
2     int data;  
3     ListNode next;  
4 }
```

How can we use code to make this list?

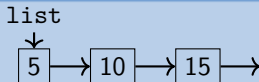



```
1 ListNode list = new ListNode();
```

ListNode Class

```
1 public class ListNode {  
2     int data;  
3     ListNode next;  
4 }
```

How can we use code to make this list?

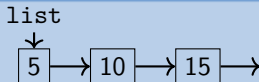




```
1 ListNode list = new ListNode();   
2 list.data = 5;
```

ListNode Class

```
1 public class ListNode {  
2     int data;  
3     ListNode next;  
4 }
```

How can we use code to make this list?

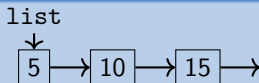





```
1 ListNode list = new ListNode();   
2 list.data = 5;   
3 list.next = new ListNode();
```

ListNode Class

```
1 public class ListNode {  
2     int data;  
3     ListNode next;  
4 }
```

How can we use code to make this list?

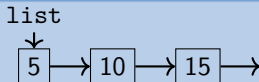





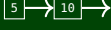
```
1 ListNode list = new ListNode();   
2 list.data = 5;   
3 list.next = new ListNode();   
4 list.next.data = 10;
```

ListNode Class

```
1 public class ListNode {  
2     int data;  
3     ListNode next;  
4 }
```

How can we use code to make this list?

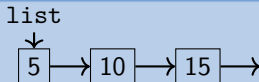





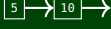
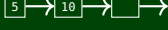
```
1 ListNode list = new ListNode();   
2 list.data = 5;   
3 list.next = new ListNode();   
4 list.next.data = 10;   
5 list.next.next = new ListNode();
```

ListNode Class

```
1 public class ListNode {  
2     int data;  
3     ListNode next;  
4 }
```

How can we use code to make this list?

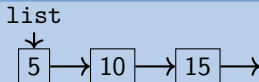


```
1 ListNode list = new ListNode();   
2 list.data = 5;   
3 list.next = new ListNode();   
4 list.next.data = 10;   
5 list.next.next = new ListNode();   
6 list.next.next.data = 15;
```


ListNode Class

```
1 public class ListNode {  
2     int data;  
3     ListNode next;  
4 }
```

How can we use code to make this list?



```
1 ListNode list = new ListNode();  
2 list.data = 5;  
3 list.next = new ListNode();  
4 list.next.data = 10;  
5 list.next.next = new ListNode();  
6 list.next.next.data = 15;
```

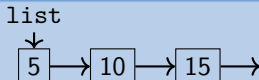
The diagram illustrates the step-by-step construction of the linked list:

- 1. A pointer 'list' points to an empty box with an arrow pointing right.
- 2. The value 5 is assigned to the 'data' field of the node pointed to by 'list'.
- 3. A new empty node is created and assigned to 'list.next'.
- 4. The value 10 is assigned to the 'data' field of the second node.
- 5. A new empty node is created and assigned to 'list.next.next'.
- 6. The value 15 is assigned to the 'data' field of the third node.

ListNode Class

```
1 public class ListNode {  
2     int data;  
3     ListNode next;  
4 }
```

How can we use code to make this list?



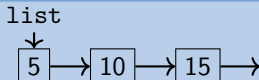
What does this code do to our list?

```
1 ListNode node = list.next;
```

ListNode Class

```
1 public class ListNode {  
2     int data;  
3     ListNode next;  
4 }
```

How can we use code to make this list?



What does this code do to our list?

```
1 ListNode node = list.next;
```

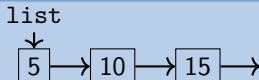


```
2 list.next = list.next.next;
```

ListNode Class

```
1 public class ListNode {  
2     int data;  
3     ListNode next;  
4 }
```

How can we use code to make this list?



What does this code do to our list?

```
1 ListNode node = list.next;
```



```
2 list.next = list.next.next;
```



```
3 list.next.next = node;
```

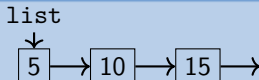
ListNode Class

```

1 public class ListNode {
2     int data;
3     ListNode next;
4 }

```

How can we use code to make this list?



What does this code do to our list?

```
1 ListNode node = list.next;
```



```
2 list.next = list.next.next;
```



```
3 list.next.next = node;
```



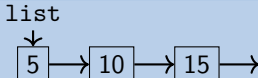
ListNode Class

```

1 public class ListNode {
2     int data;
3     ListNode next;
4 }

```

How can we use code to make this list?



What does this code do to our list?

1 `ListNode node = list.next;`



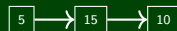
2 `list.next = list.next.next;`



3 `list.next.next = node;`



This isn't quite



What's wrong?

```
list.next.next.next = list.next;
```

list



The code sets **the arrow** coming out of c to **the node** d.

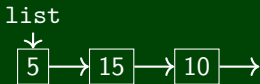
list



The **left side** of the assignment is **an arrow**.

The **right side** of the assignment is **a node**.

When we call `.next`, we follow an **arrow** in the list. What happens if we have this list:



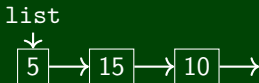
And we call the following code:

```
1 System.out.println(list.next.next.next);
```

Or this code:

```
1 System.out.println(list.next.next.next.data);
```


When we call `.next`, we follow an **arrow** in the list. What happens if we have this list:



And we call the following code:

```
1 System.out.println(list.next.next.next);
```

Or this code:

```
1 System.out.println(list.next.next.next.data);
```

The first one prints `null`. The second throws a `NullPointerException`.

`null` means “end of the list”!

```
1 public class ListNode {
2     int data;
3     ListNode next;
4
5     public ListNode(int data) {
6         this(data, null);
7     }
8
9     public ListNode(int data, ListNode next) {
10        this.data = data;
11        this.next = next;
12    }
13 }
```

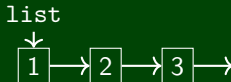
What list does this code make?

```
ListNode list = new ListNode(1, null);
list.next = new ListNode(2, null);
list.next.next = new ListNode(3, null);
```

```
1 public class ListNode {
2     int data;
3     ListNode next;
4
5     public ListNode(int data) {
6         this(data, null);
7     }
8
9     public ListNode(int data, ListNode next) {
10        this.data = data;
11        this.next = next;
12    }
13 }
```

What list does this code make?

```
ListNode list = new ListNode(1, null);
list.next = new ListNode(2, null);
list.next.next = new ListNode(3, null);
```

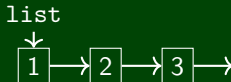


Can we do this without ever using `.next`?

```
1 public class ListNode {
2     int data;
3     ListNode next;
4
5     public ListNode(int data) {
6         this(data, null);
7     }
8
9     public ListNode(int data, ListNode next) {
10        this.data = data;
11        this.next = next;
12    }
13 }
```

What list does this code make?

```
ListNode list = new ListNode(1, null);
list.next = new ListNode(2, null);
list.next.next = new ListNode(3, null);
```



Can we do this without ever using `.next`?

```
ListNode list = new ListNode(1, new ListNode(2, new ListNode(3, null)));
```