

Building Java Programs

Chapter 16
Linked Nodes

reading: 16.1



Road Map

CS Concepts

- Client/Implementer
- Efficiency
- Recursion
- Regular Expressions
- Grammars
- Sorting
- Backtracking
- Hashing
- Huffman Compression

Data Structures

- Lists
- Stacks
- Queues
- Sets
- Maps
- Priority Queues

Java Language

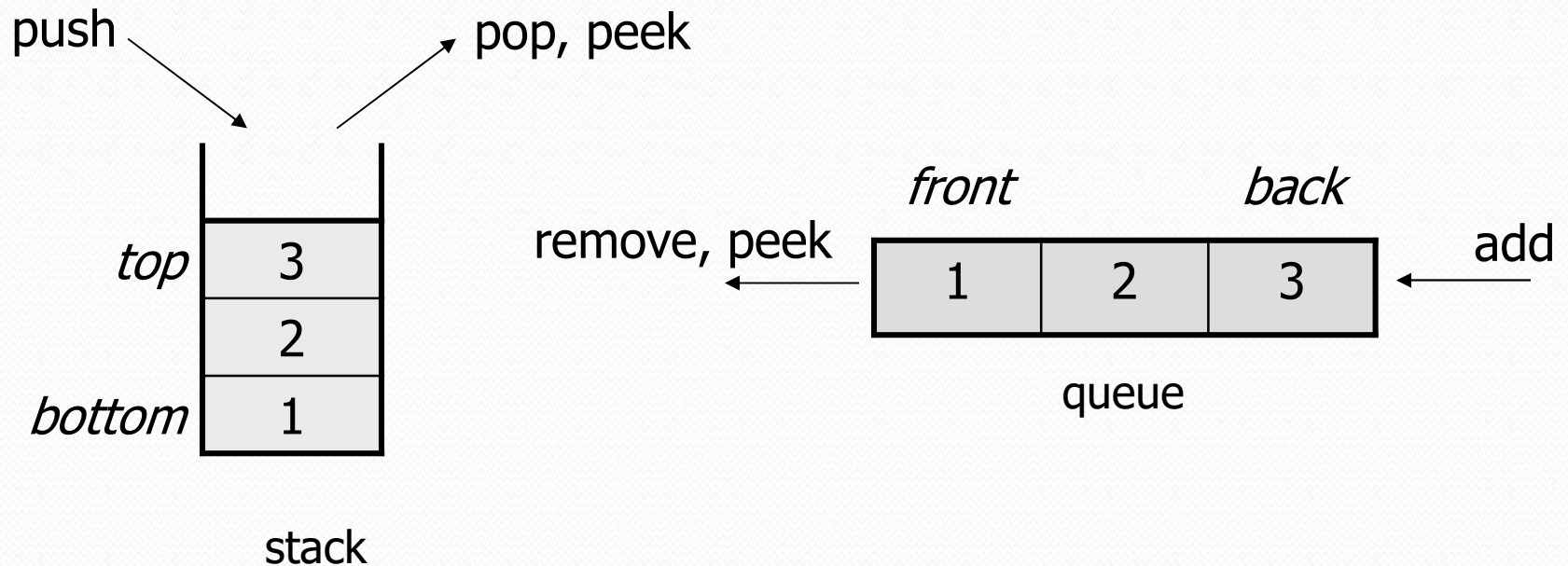
- Exceptions
- Interfaces
- References
- Comparable
- Generics
- Inheritance/Polymorphism
- Abstract Classes

Java Collections

- Arrays
- ArrayList 
- LinkedList 
- Stack
- TreeSet / TreeMap
- HashSet / HashMap
- PriorityQueue

Recall: stacks and queues

- **stack**: retrieves elements in reverse order as added
- **queue**: retrieves elements in same order as added



Array vs. linked structure

- All collections in this course use one of the following:
 - an **array** of all elements
 - examples: `ArrayList`, `Stack`, `HashSet`, `HashMap`

42	-3	17	9
----	----	----	---

- **linked objects** storing a value and references to other(s)
 - examples: `LinkedList`, `TreeSet`, `TreeMap`



- First, we will learn how to create a *linked list*.
- To understand linked lists, we must understand *references*.

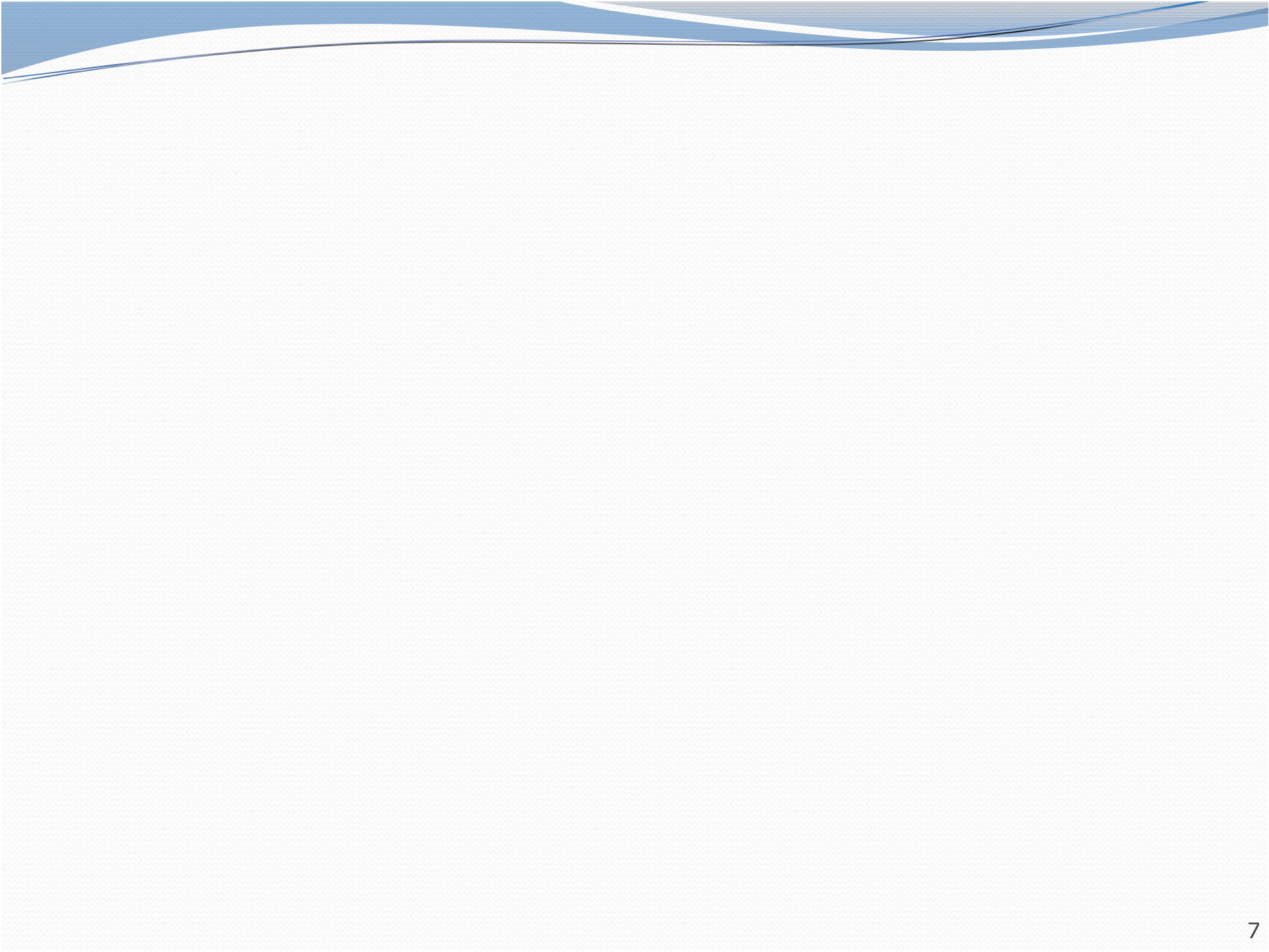
Memory for a List

- Array (contiguous in memory)

42	-3	17	9
----	----	----	---

- Spread in memory

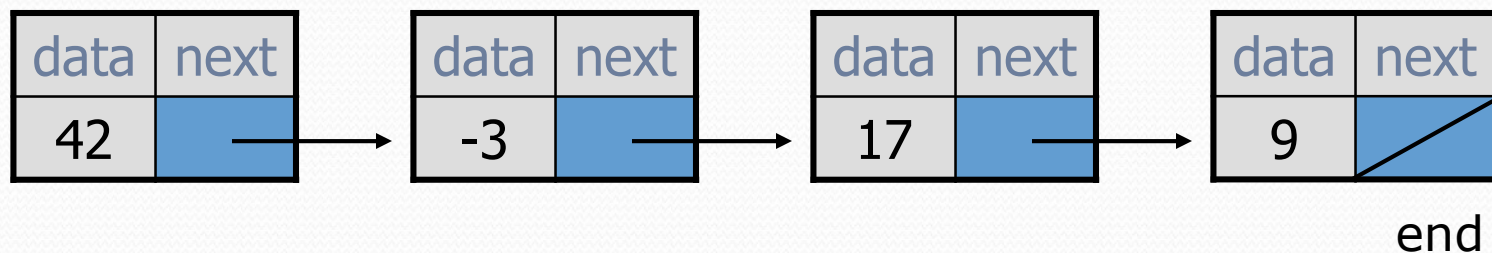
42			9		-3			17
----	--	--	---	--	----	--	--	----



A list node class

```
public class ListNode {  
    public int data;  
    public ListNode next;  
}
```

- Each list node object stores:
 - one piece of integer data
 - a reference to another list node
- `ListNode`s can be "linked" into chains to store a list of values:



References to same type

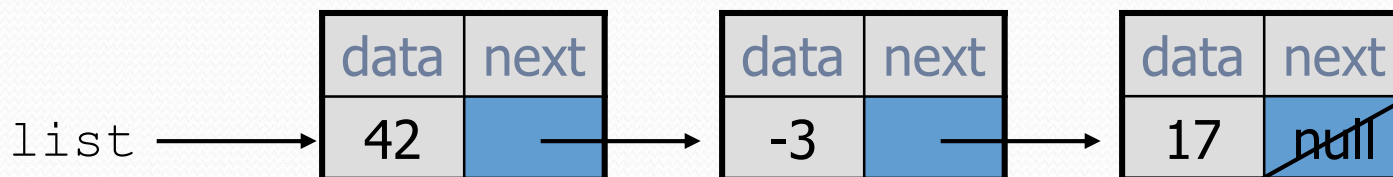
- What would happen if we had a class that declared one of its own type as a field?

```
public class Strange {  
    private String name;  
    private Strange other;  
}
```

- Will this compile?
 - If so, what is the behavior of the `other` field? What can it do?
 - If not, why not? What is the error and the reasoning behind it?

List node client example

```
public class ConstructList1 {  
    public static void main(String[] args) {  
        ListNode list = new ListNode();  
        list.data = 42;  
        list.next = new ListNode();  
        list.next.data = -3;  
        list.next.next = new ListNode();  
        list.next.next.data = 17;  
        list.next.next.next = null;  
        System.out.println(list.data + " " + list.next.data  
                             + " " + list.next.next.data);  
  
        // 42 -3 17  
    }  
}
```



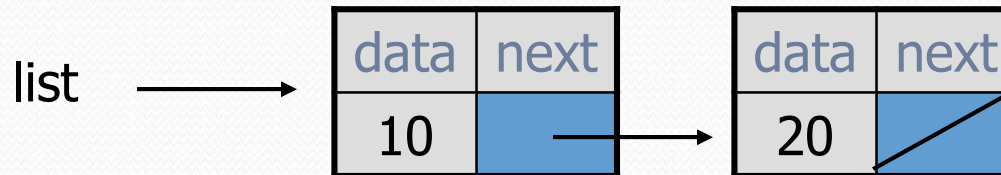
List node w/ constructor

```
public class ListNode {  
    int data;  
    ListNode next;  
  
    public ListNode(int data) {  
        this(data, null);  
    }  
  
    public ListNode(int data, ListNode next) {  
        this.data = data;  
        this.next = next;  
    }  
}
```

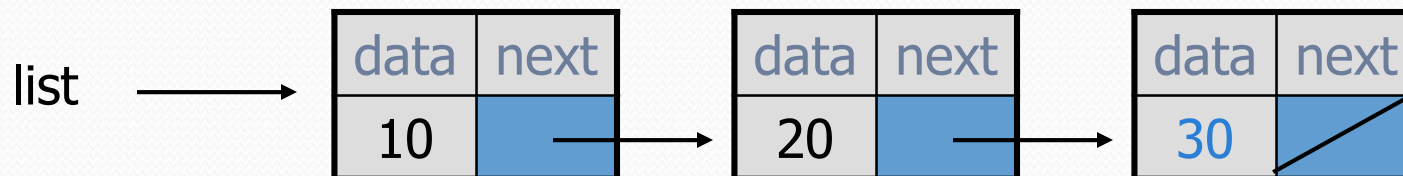
- Exercise: Modify the previous client to use these constructors.

Linked node problem 1

- What set of statements turns this picture:

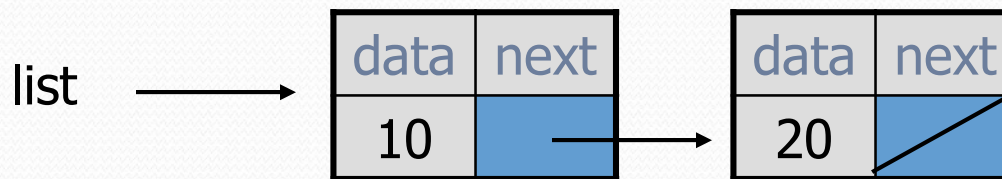


- Into this?

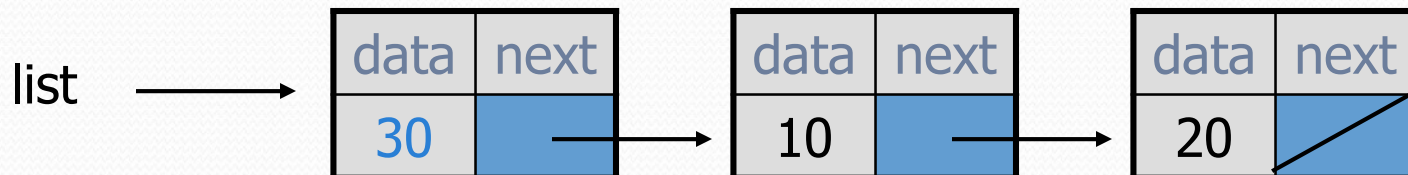


Linked node problem 2

- What set of statements turns this picture:

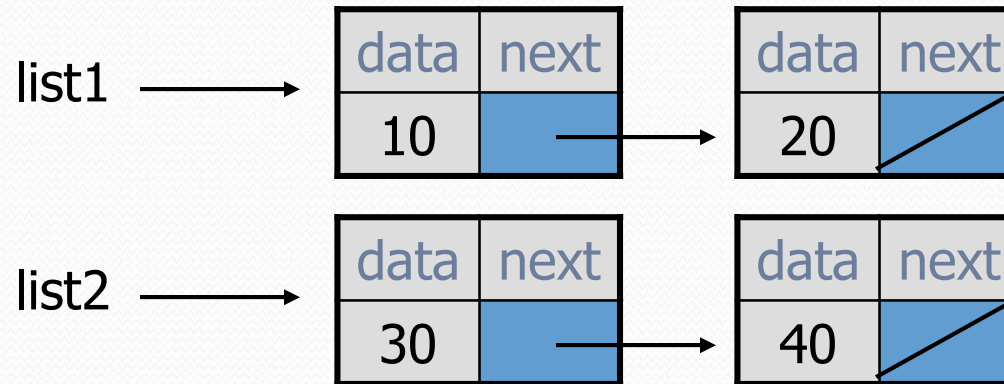


- Into this?

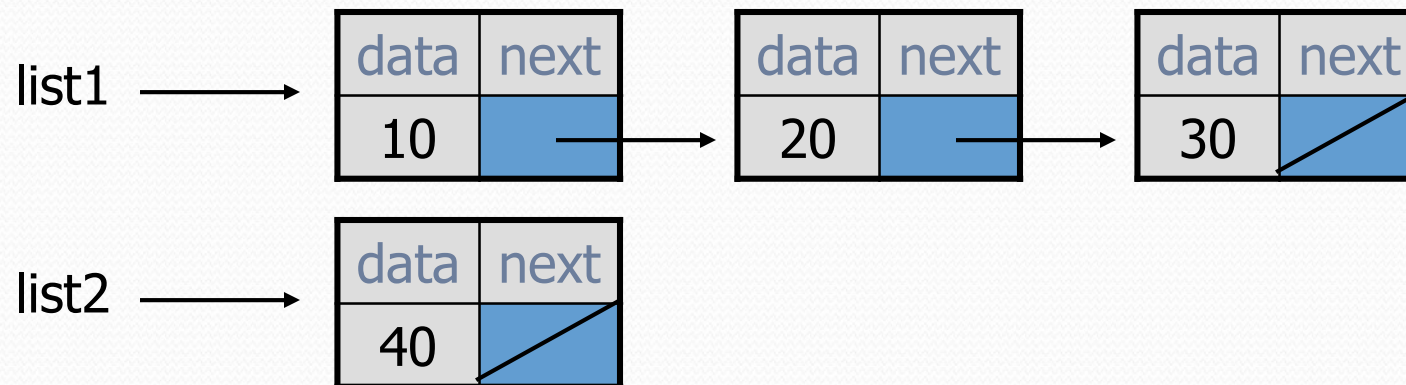


Linked node problem 3

- What set of statements turns this picture:

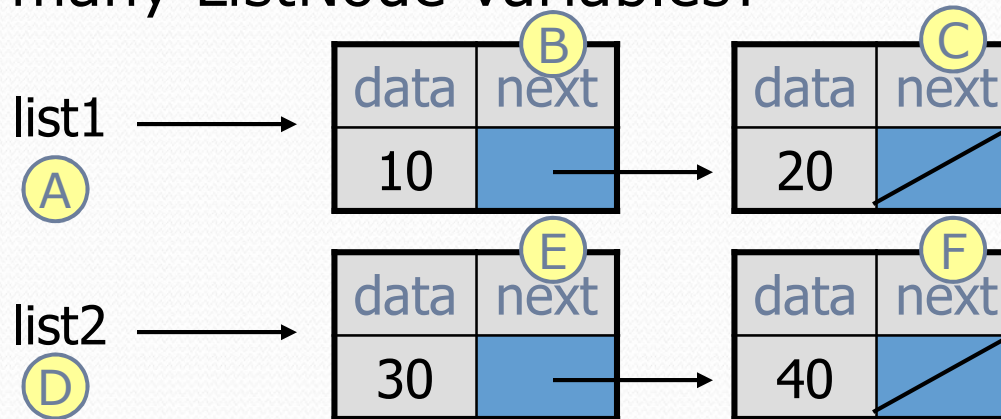


- Into this?

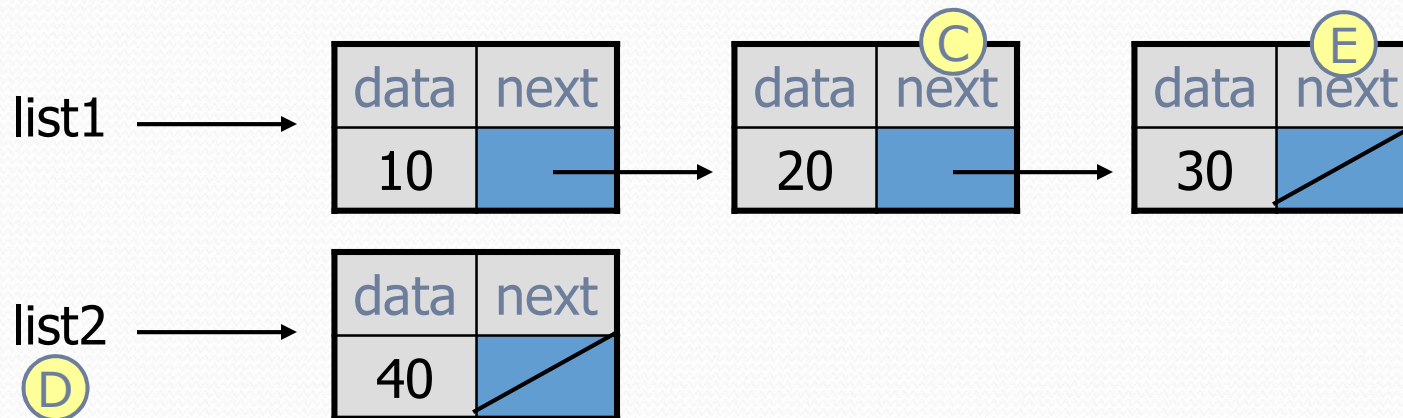


Linked node problem 3

- How many ListNode variables?

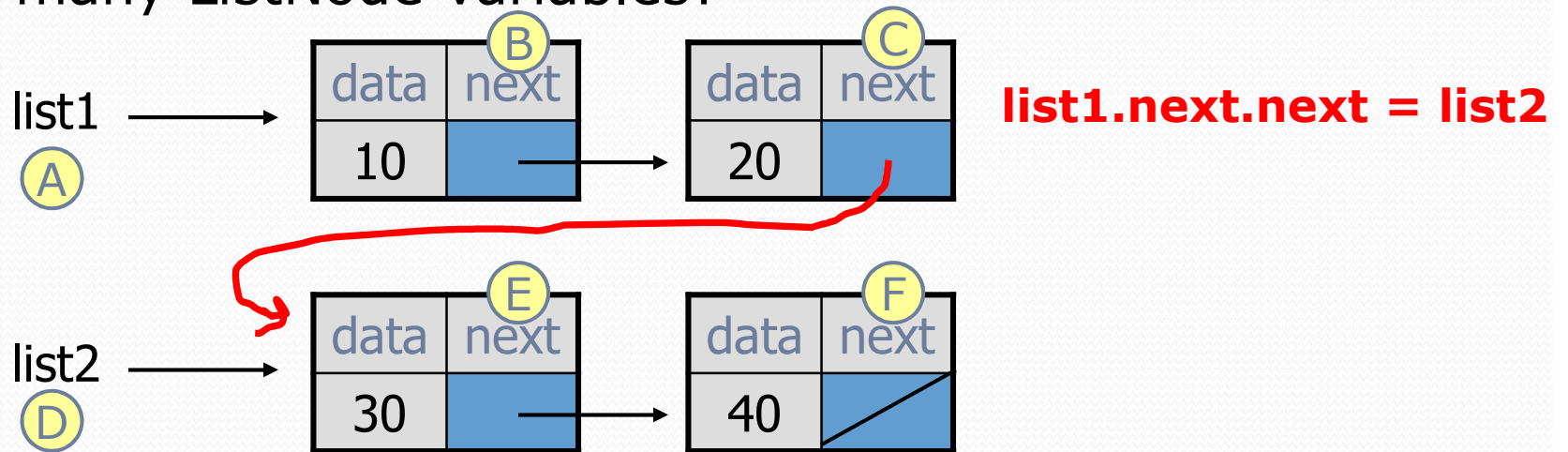


- Which variables change?

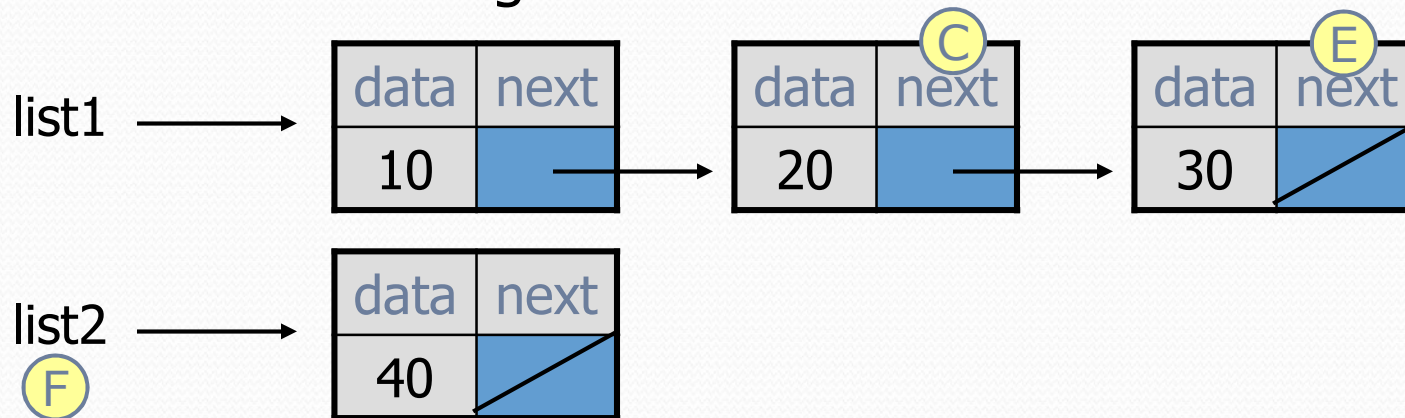


Linked node problem 3

- How many ListNode variables?

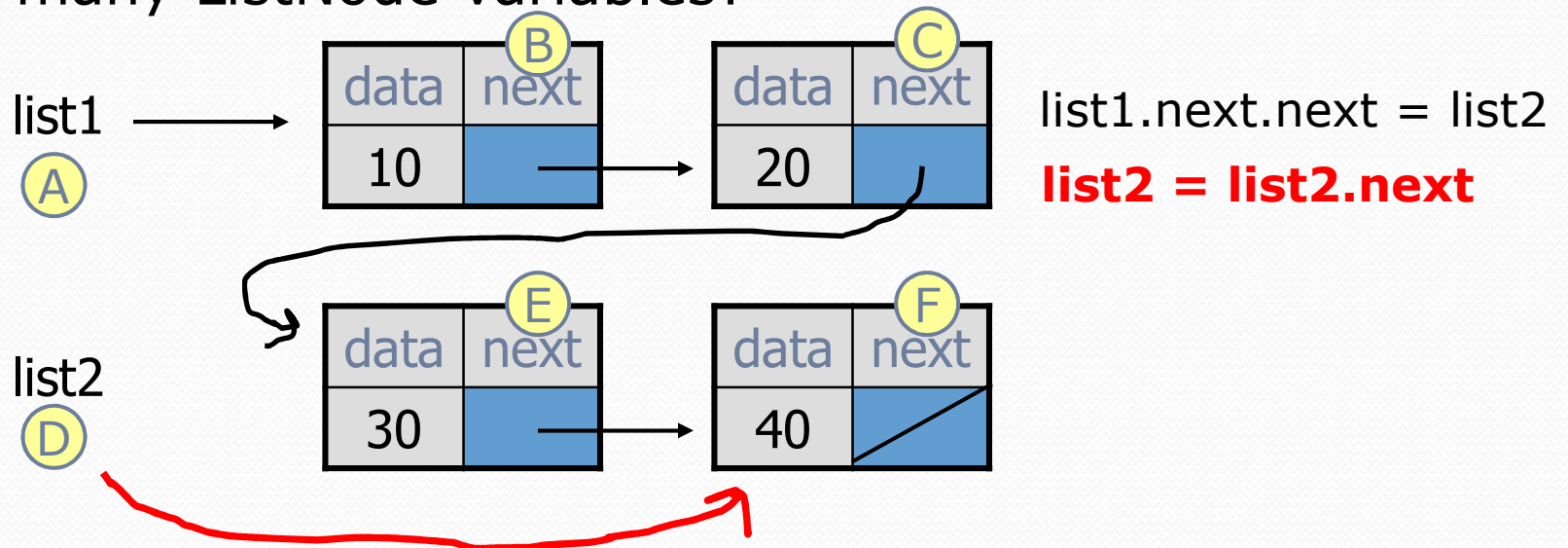


- Which variables change?

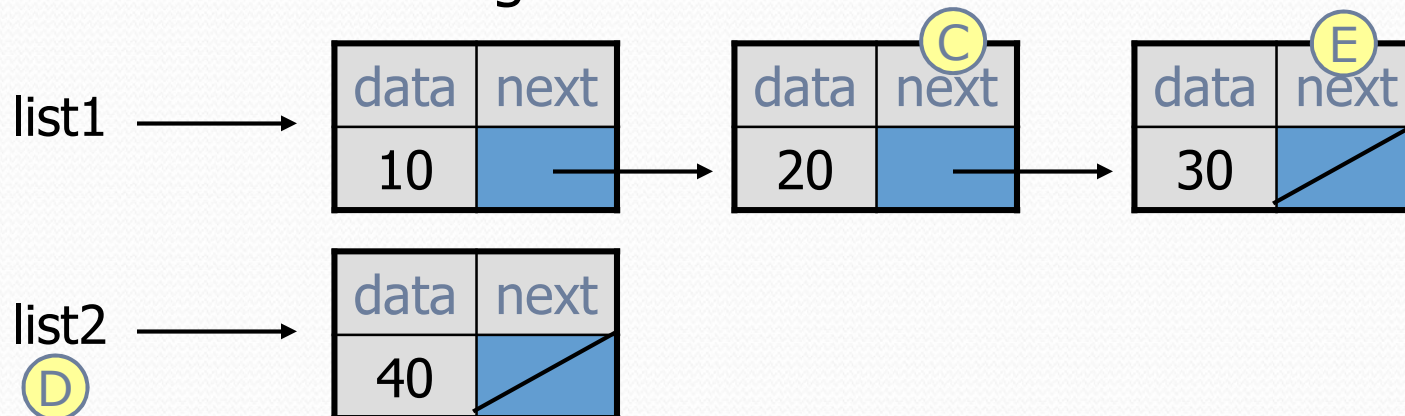


Linked node problem 3

- How many ListNode variables?

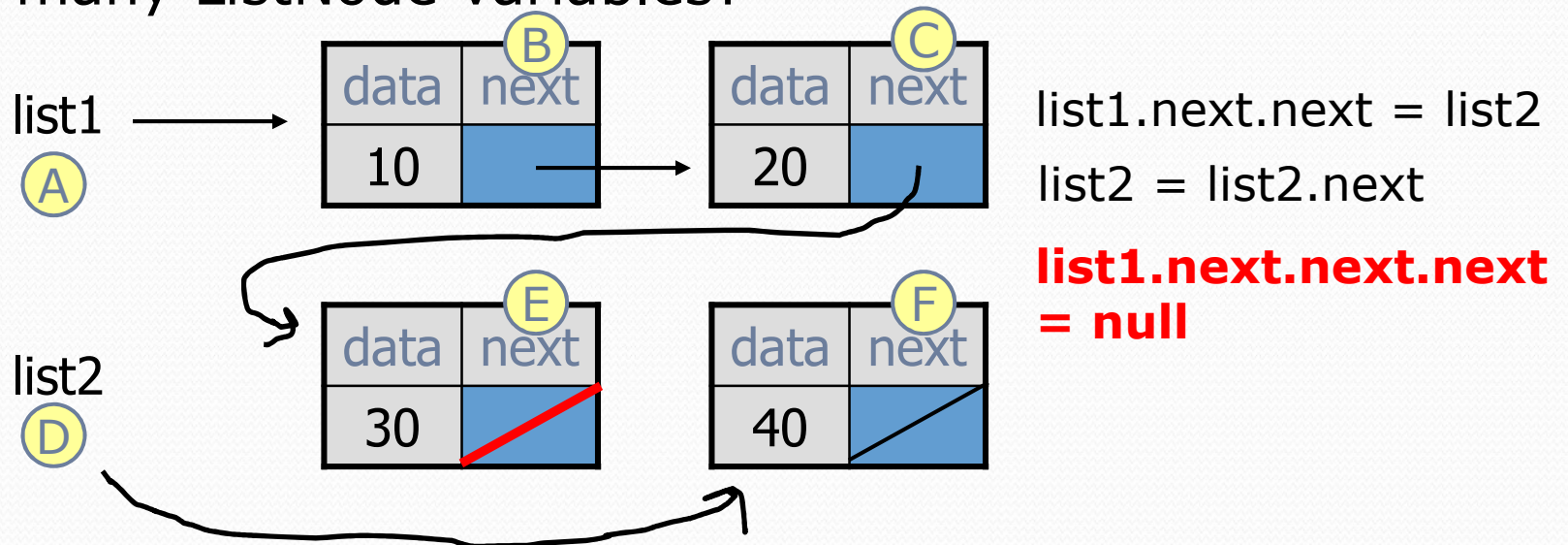


- Which variables change?

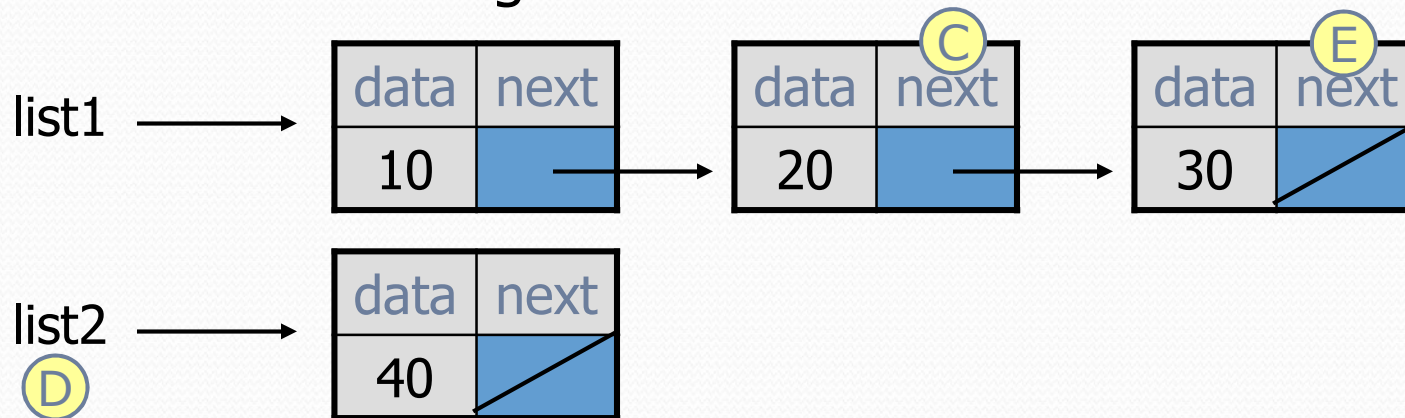


Linked node problem 3

- How many ListNode variables?

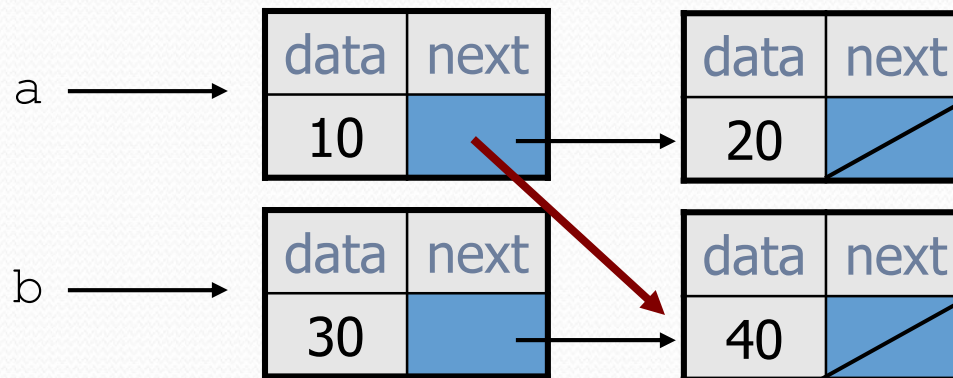


- Which variables change?



Reassigning references

- when you say:
 - `a.next = b.next;`
- you are saying:
 - "Make *variable* `a.next` refer to the same *value* as `b.next`."
 - Or, "Make `a.next` point to the same place that `b.next` points."



References vs. objects

variable = value;

a *variable* (left side of =) place to put a reference

(where the phone number goes; where the base of the arrow goes)

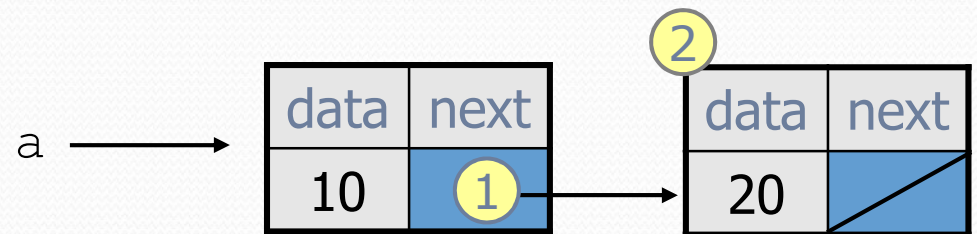
a *value* (right side of =) is the reference itself

(the phone number; the destination of the arrow)

- For the list at right:

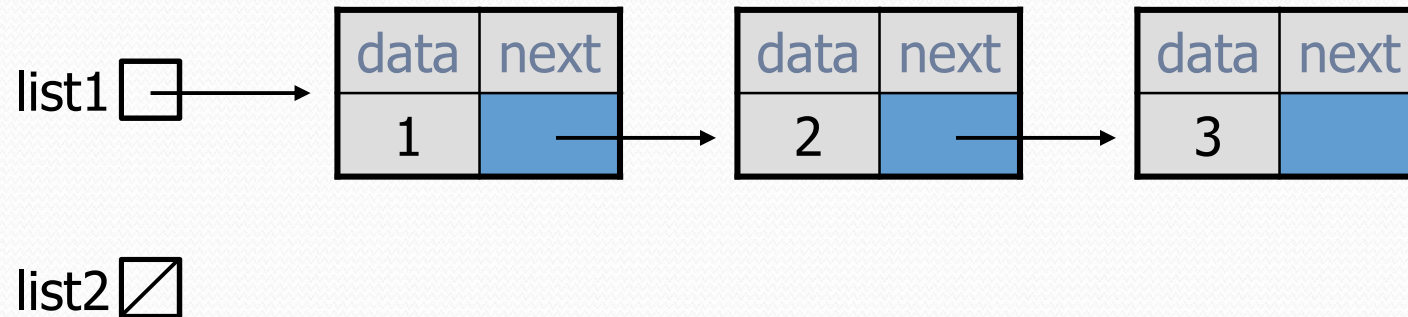
- `a.next = value;` ①
means to adjust where ① points

- `variable = a.next;` ②
means to make **variable** point at ②



Linked node problem 4

- What set of statements turns this picture:



- Into this?

