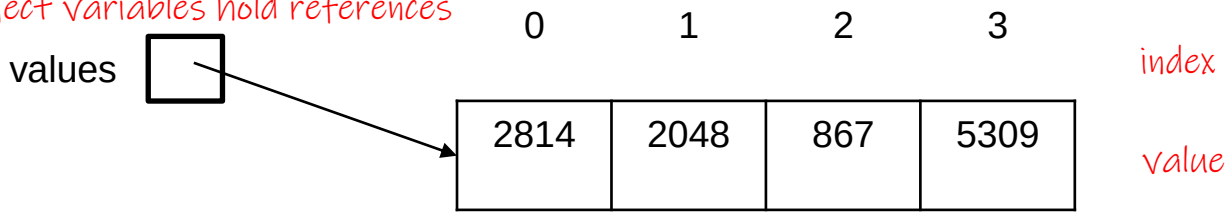
Linked Nodes

Previously: Arrays

- Previously, if we ever wanted to store a sequence of data, we used arrays
- Arrays store data in contiguous memory (each element is next to each other in memory)
    - We could access a specific position with an index
- Example array declaration:

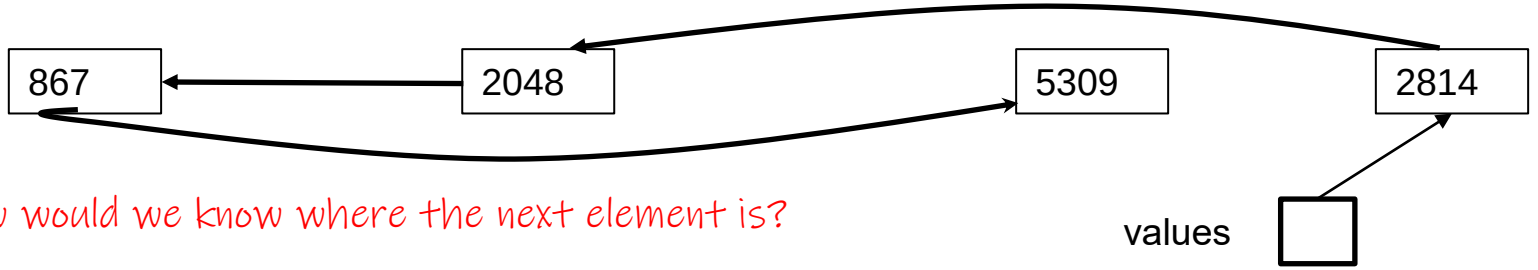
```
int[] values = {2814, 2048, 867, 5309};
```

Remember an array is an object.
Object variables hold references



Idea: Non-contiguous storage

- What if we tried to store data in memory that is noncontiguous (e.g. each element is spread apart from one another)
- Consider the data `{2814, 2048, 867, 5309}`



How would we know where the next element is?

- Keep track of the first element (just like arrays) and have each value store a reference to the "next" value

Introduction: Linked Nodes

- Linked node: a class containing one or more data fields that store data, and a *reference* to another linked node
- Linked nodes connect objects together to form a list (chain) of link nodes
- Linked nodes are the building blocks of programs (data structures) that store a large amount of data without using an array
    - Allow us to more easily modify a collection of data
    - Don’t have to worry about knowing the length before hand

In the next few lectures
For now: get comfortable
with nodes

Node class

- Below are two examples of linked node classes.

```
public class Node {
  public Node next; // Point to next node
  public int data;  // Value (int) for this node
  // Constructor
  public Node(int data, Node next) {
    this.data = data;
    this.next = next;
  }

  //data fields are public
  // no need for getters and setters

}
```

This node will store an int value

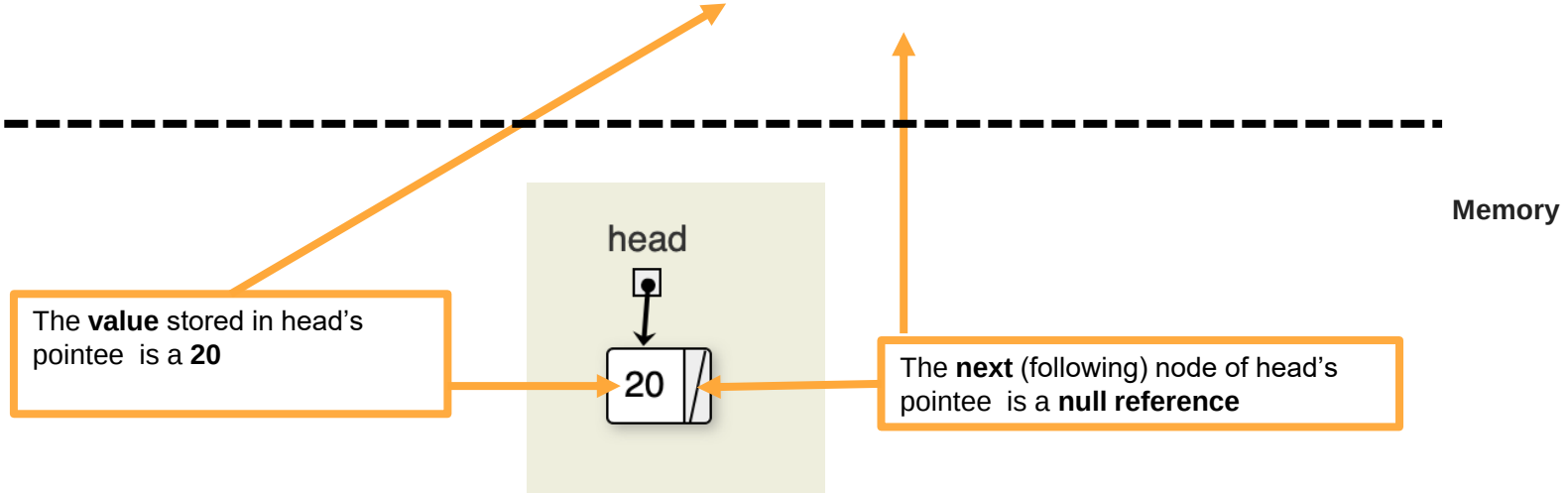
```
public class Node {
  public Node next;     // Point to next node
  public Computer data; // Value (Computer)for this node
  // Constructor
  public Node(Computer data, Node next) {
    this.data = data;
    this.next = next;
  }

   // data fields are public
   // no need for getters and setters

}
```

This node will store a Computer value

Chain of nodes

- Let's build a chain of nodes.
- Each node stores an integer value

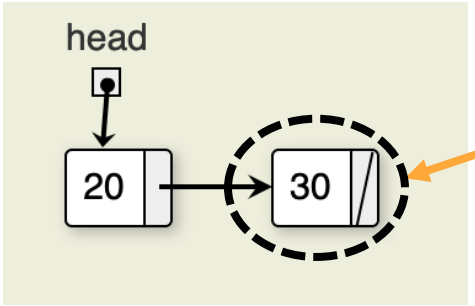
```
Node head =    new Node(20, null);
```



Chain of nodes

- `head.next = new Node(30, null);`

Update/add a new node at the end of the chain



Memory

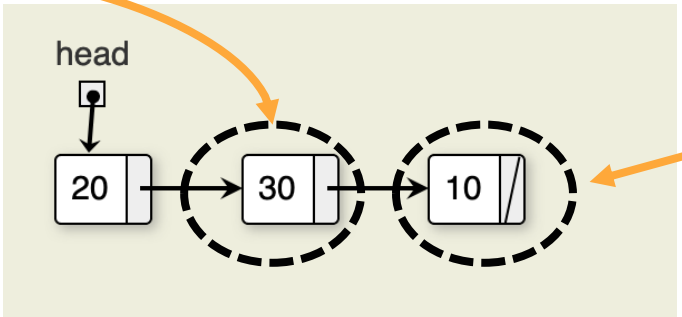
The **next** (follower) node of head's pointee is a **new Node storing 30**

Chain of nodes

- `head.next.next = new Node(10, null);`

Evaluates to head's next (follower) node

The **next** (following) node of head's follower is a **new Node storing 10**

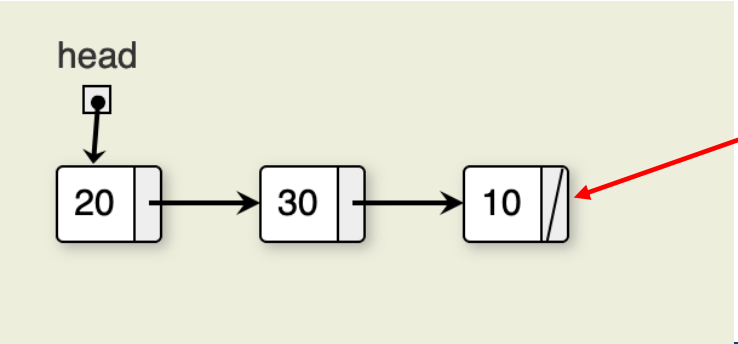


Chain of nodes

Putting everything together:

```
Node head = new Node(20, null);
head.next = new Node(30, null);
head.next.next = new Node(10, null);
```

Will create the following chain:



The last node has NULL as its next to mark that there are no more nodes

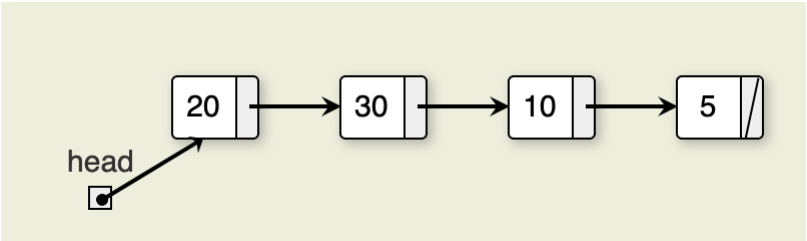
Chain of nodes: iteration

- To iterate through a chain of nodes:
- We don’t need to know how many nodes are in the chain
- The last `node`'s next field is a `null` reference
- Steps :

1. Create a temporary node that points to the head of the chain (sharing)
2. Iterate/loop by following the next references with each iteration, update the pointee of the temporary node
3. Stop when the temporary node points to a null reference

Chain of nodes: iteration

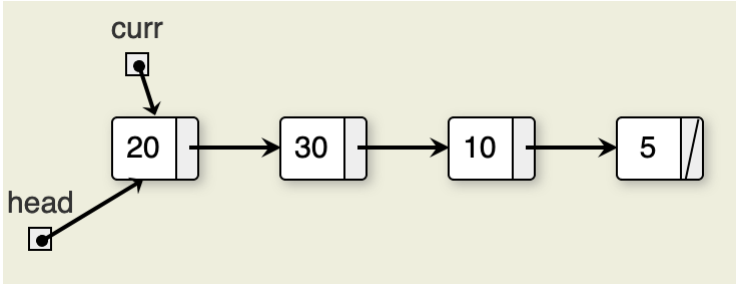
- Given the following chain



Chain of nodes: iteration

- Create a temporary node that points to the head of the chain

```
Node curr = head; //curr and head are aliases for each other
```



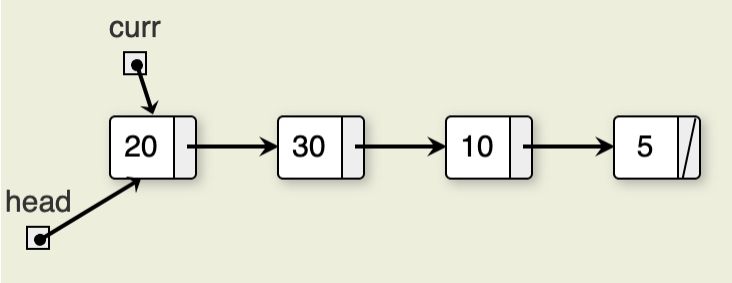
Chain of nodes: iteration

- Create a temporary node that points to the head of the chain

```
Node curr = head; //curr and head are aliases for each other
```

- Start the loop we stop when `curr` points to the last node in the chain

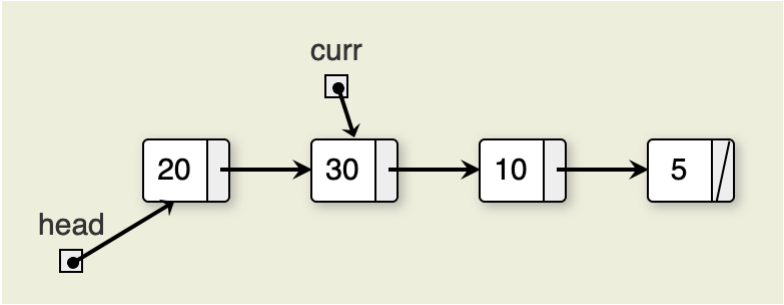
```
while(curr != null){  // the pointee of curr is not null
    curr = curr.next;  //we advance curr
}
```



Chain of nodes: iteration

- `Curr` now points to the node storing 30

```
while(curr != null){  // the pointee of curr is not null
    curr = curr.next;  //we advance curr
}
```

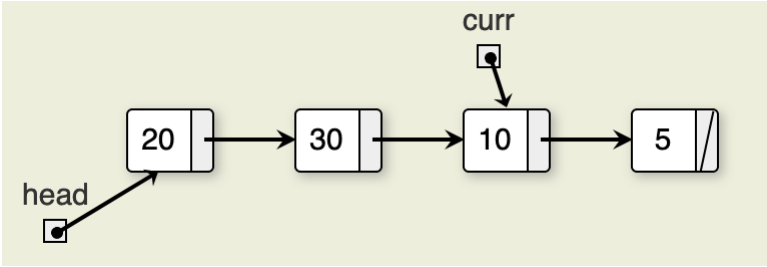


Note that `head` did not move.

Chain of nodes: iteration

- Curr now points to the node storing 10

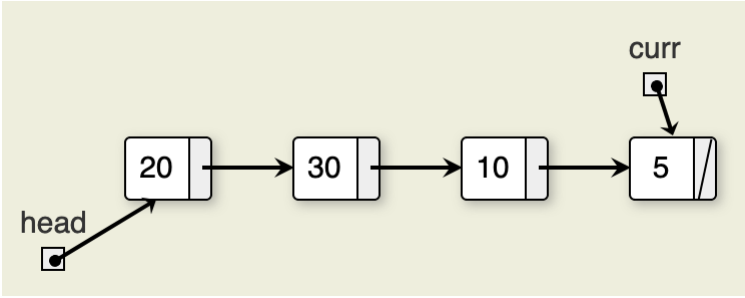
```
while(curr != null){  // the pointee of curr is not null
    curr = curr.next;  //we advance curr
}
```



Chain of nodes: iteration

- Curr now points to the node storing 5

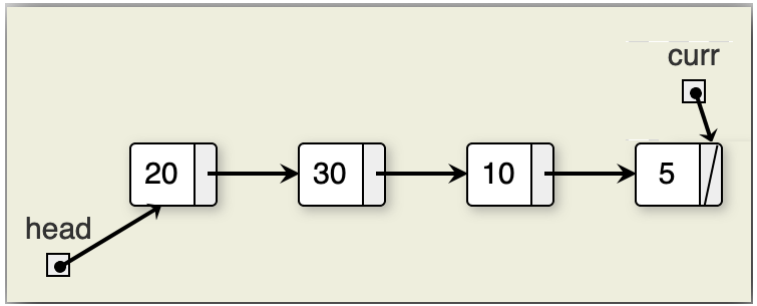
```
while(curr != null){  // the pointee of curr is not null
    curr = curr.next;  //we advance curr
}
```



Chain of nodes: iteration

- Curr is now a null reference

```
while(curr != null){  // the pointee of curr is now null
    curr = curr.next;  //we exit the loop ⚠
}
```

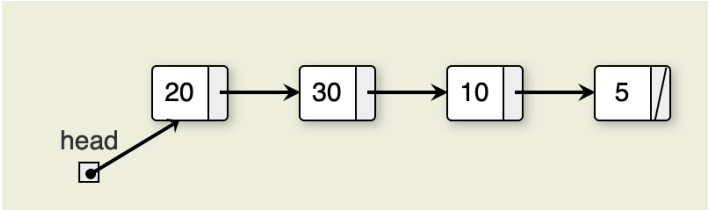


Chain of nodes: iteration

- Putting everything together:
- The following code will print all the values stored in our chain

```
Node curr = head;
while(curr != null){
    System.out.print(curr.data);
    curr = curr.next;
}
```

Will print: `20 30 10 5`



Chain of nodes: iteration (for loop)

- Putting everything together:
- The following code will print all the values stored in our chain

```
for(Node curr = head; curr != null; curr = curr.next){
    System.out.print(curr.data);
}
```

Will print: `20 30 10 5`