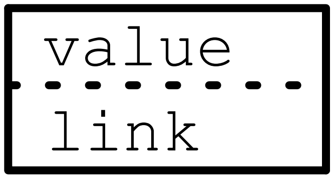
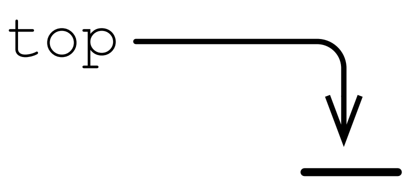
A linked list node has two members:
a **value** that holds user data, and
a **link** that refers to the next node.



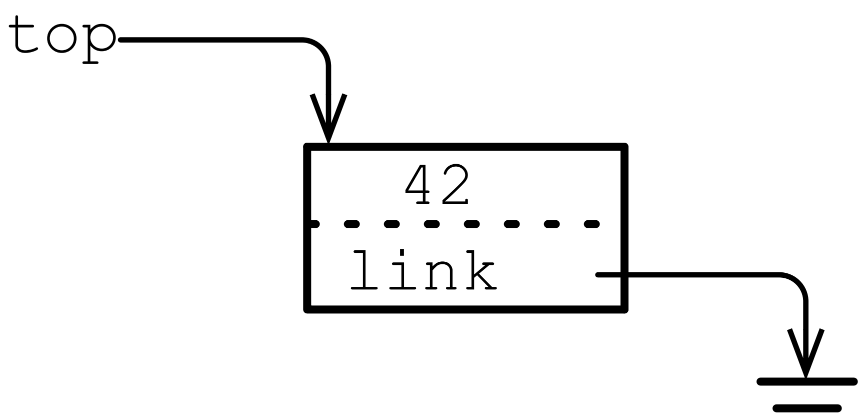
This is an individual
linked list node.

You need a pointer to the first node.
This variable is the same data type as
the 'link' member in a linked list node.
Call it 'top'. Initially 'top' points
to nothing, or NULL. Drawn as:



This means there's a pointer to null.
It signifies that there is no more
data.

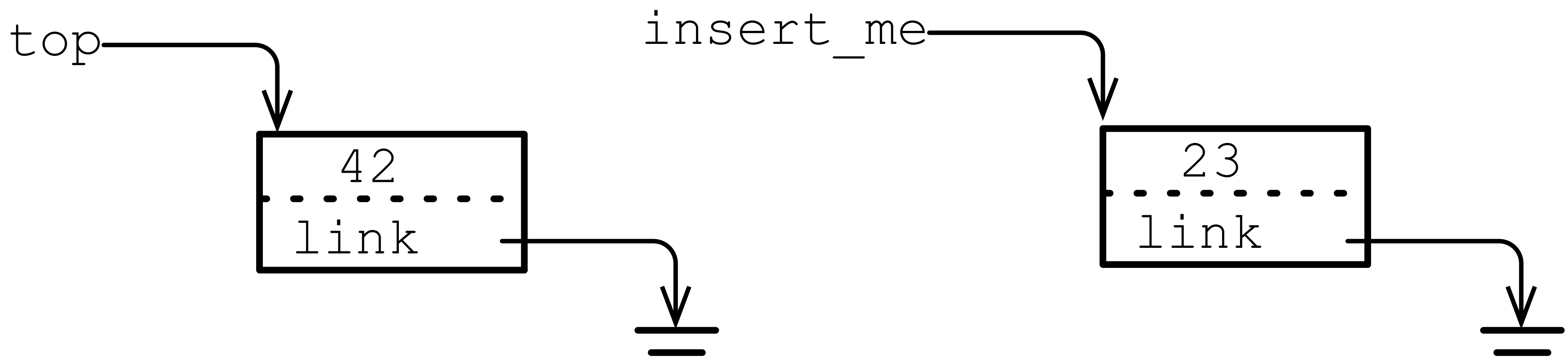
An empty list is not very interesting, but every list must start somewhere. Let's make a list that has a single node with the value '42'.
It looks like this:



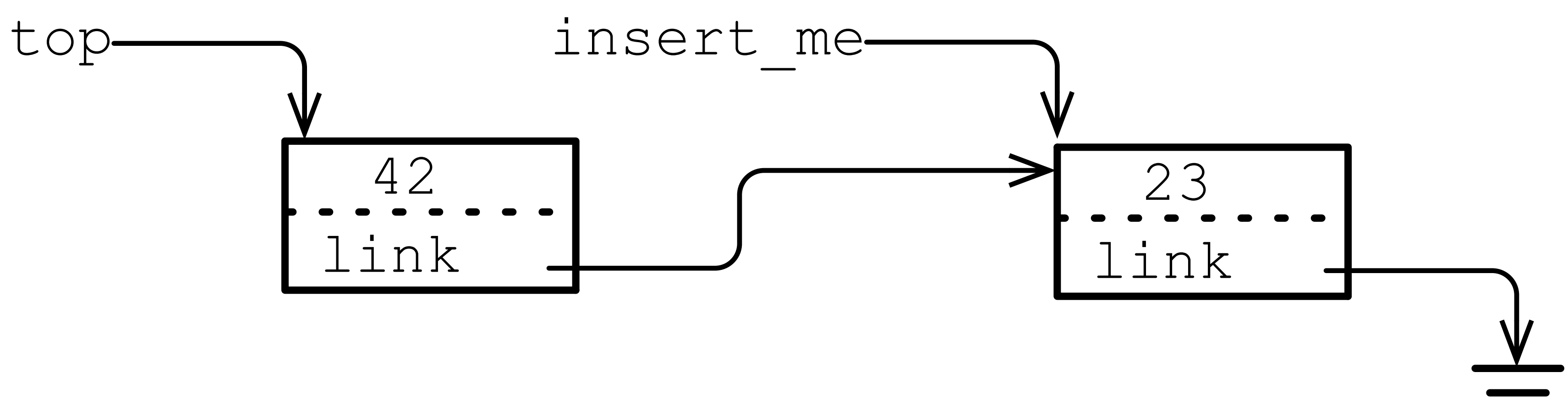
When you make a new node, you should specify the value for it to contain.

New nodes also have a null link. This means they are the end of the list.

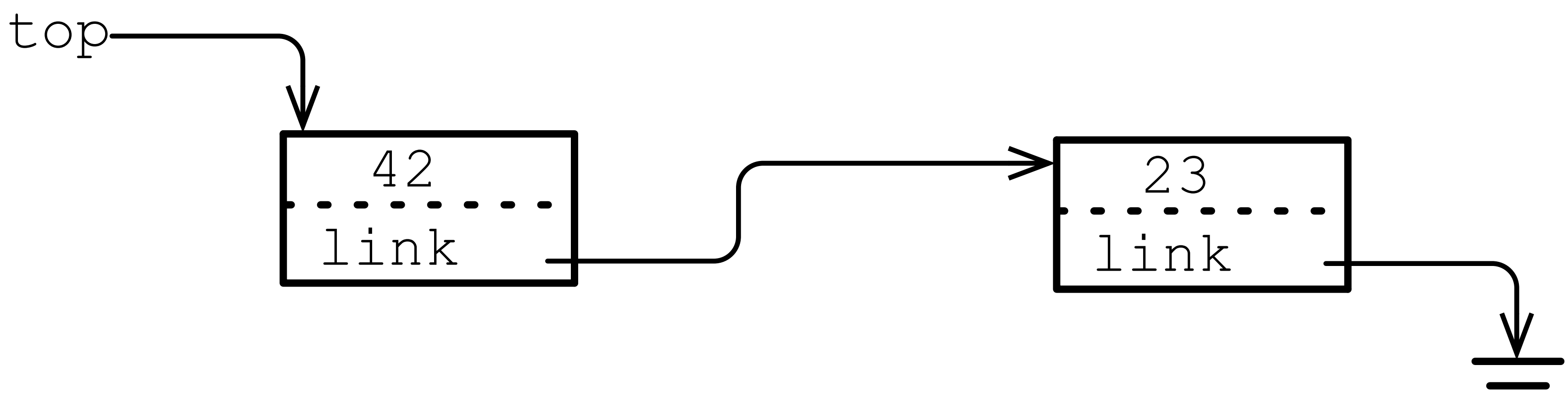
What if we want to **append** the number 23? We have to create a new node (call it 'insert_me').



But our list pointed to by 'top' still only has one element. We have to adjust the first node to point to our new 'insert_me' node:

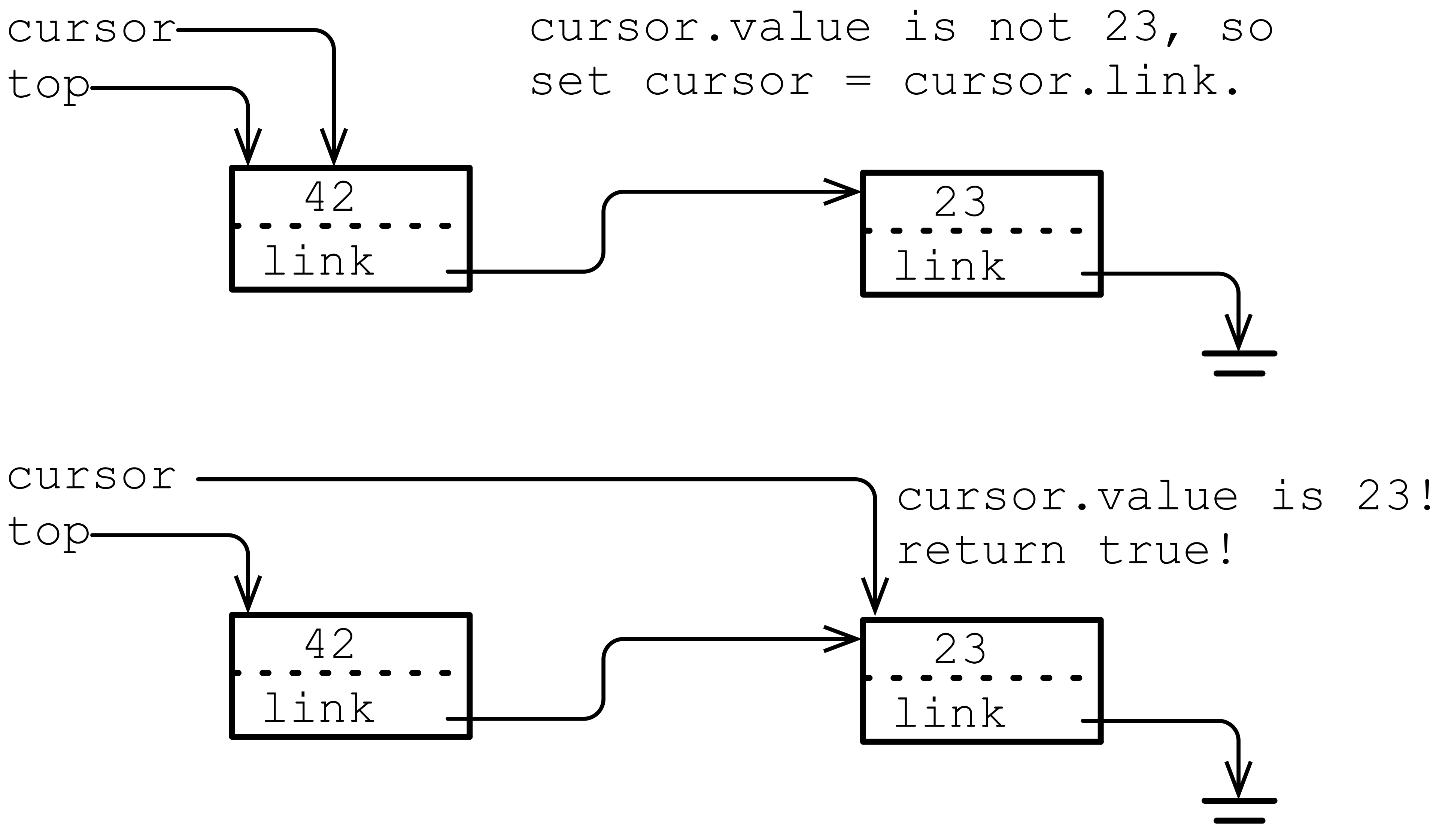


Note: the 'insert_me' variable is no longer needed.

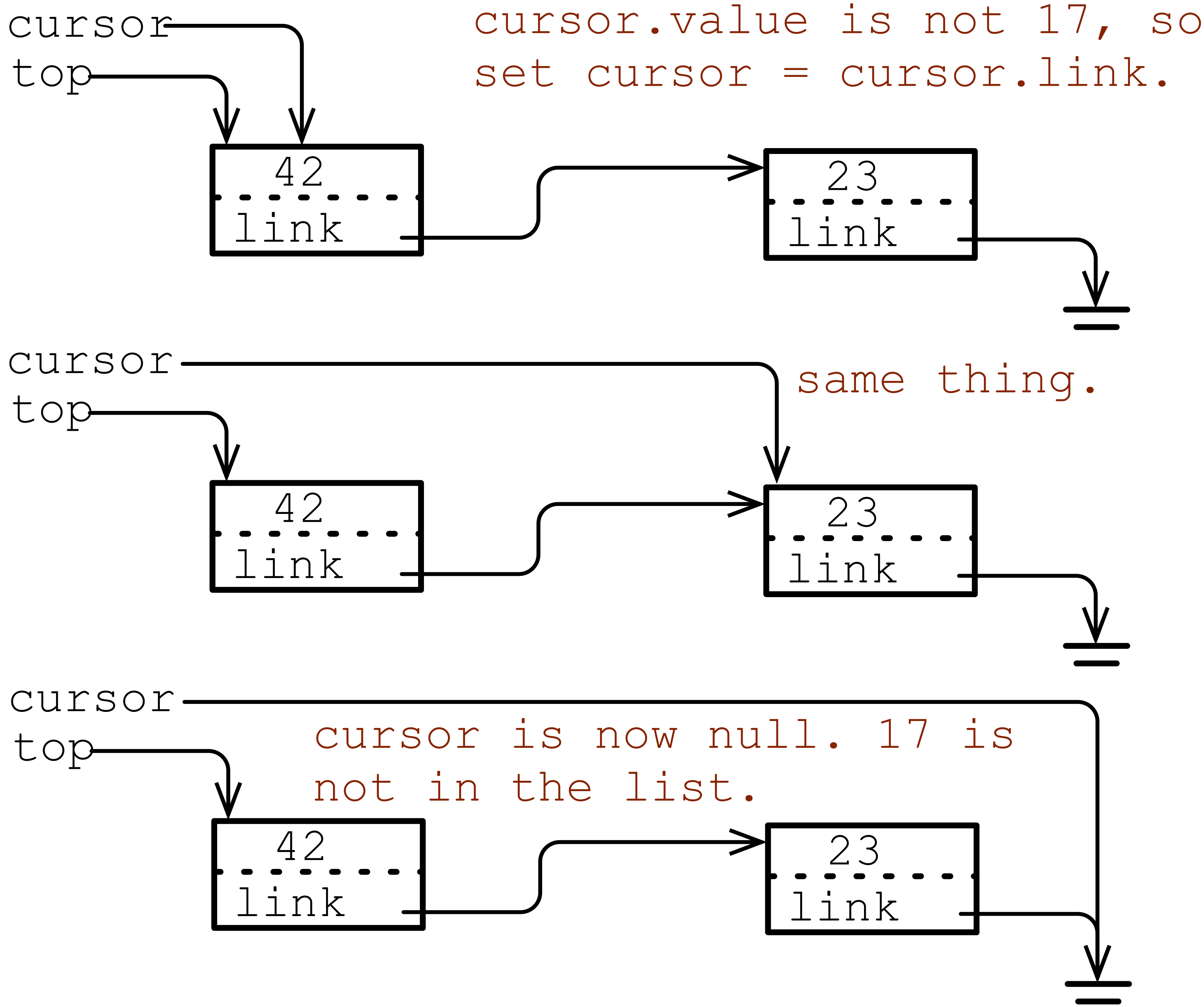


We can query the list pointed to by 'top' to see if it **contains** a certain datum. To do this, start at 'top', and examine a node value. If it is a match, declare success and return true. Otherwise, move to the next node if there is one. If this process reaches the end (indicated by a null link), we know the list does not have it, so the result is false.

To perform this scan, maintain a 'cursor' variable that points to the node we are currently inspecting. Say we are looking for '23':

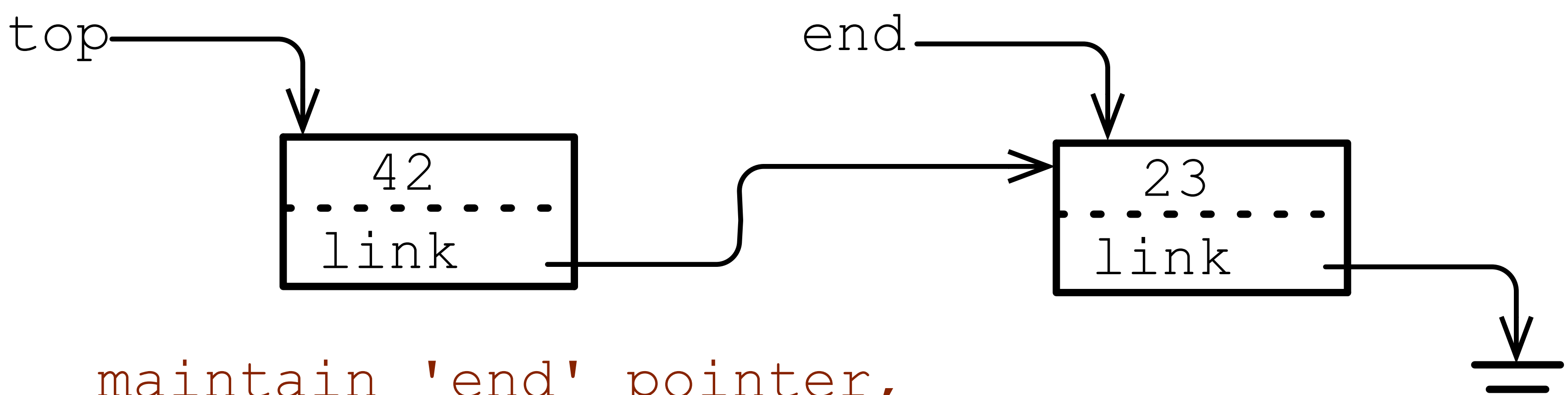


Now say we are looking for '17'.

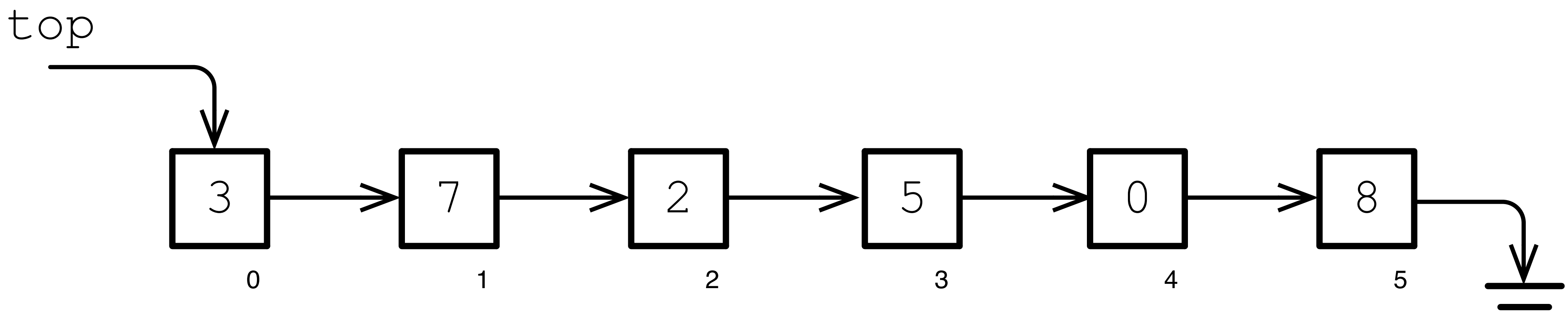


Remember when we **append**ed to the list? We cheated! In general you can't tell how long a list is, so you will need to use a cursor for appending.

The trick is to have a function that scans for the end of the list, *or* to always keep a variable that refers to the final node. Either way, you will need a way to refer to the end.



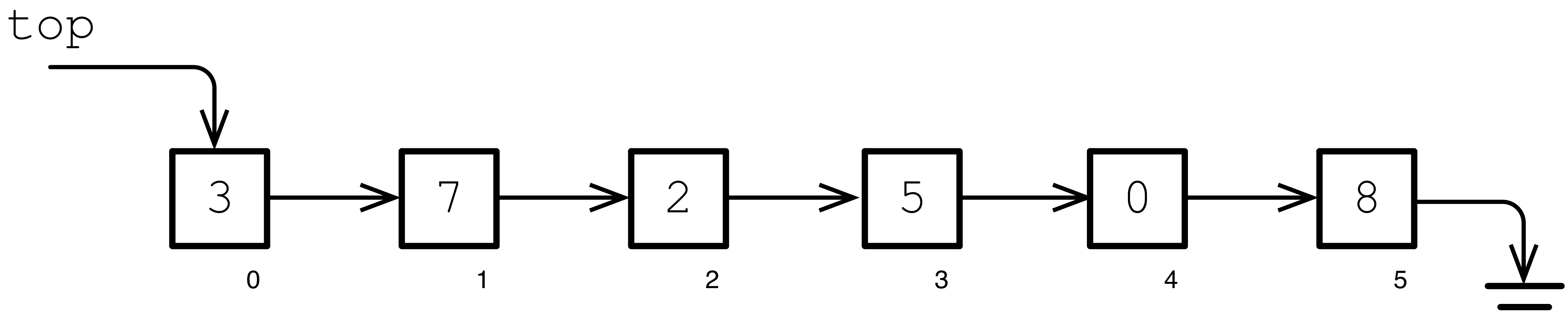
maintain 'end' pointer,
or,
write a 'scan_to_end' function.



We can **retrieve** a value by an offset. Say we want to get the number at index 3. Remember that we count starting from zero. So, the value at index number 3 is 5.

This is essentially a scan where we start at 'top' and follow the pointers until we've gone far enough.

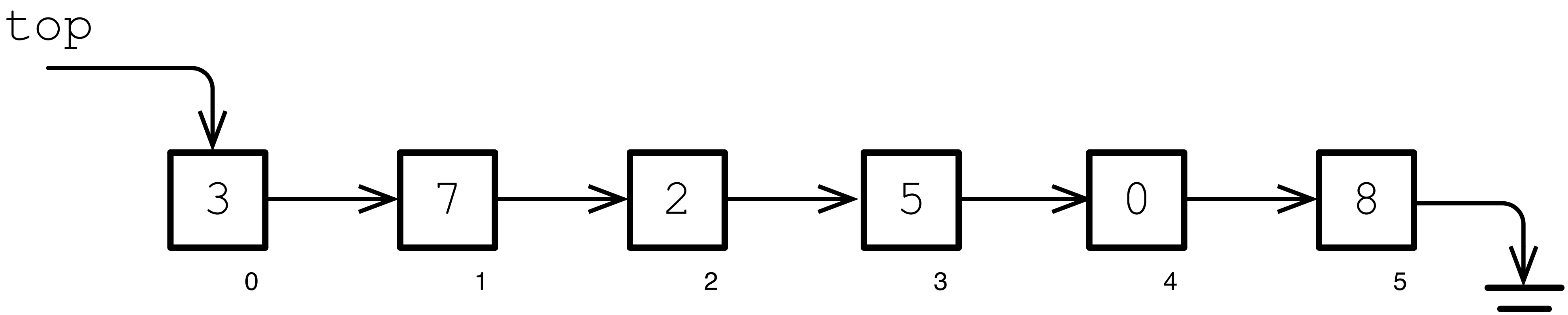
Keep in mind that the user might ask for an index that doesn't exist! Your program should not crash if this happens.



We can query the **size** of the linked list in a similar manner. Instead of looking for a particular index, we count nodes as we look for the null link that indicates the end of the list.

Remember: if the last index is 5, it means there are 6 nodes. If the last index is N, then there are N+1 nodes.

Drawing a picture helps make this sink in.

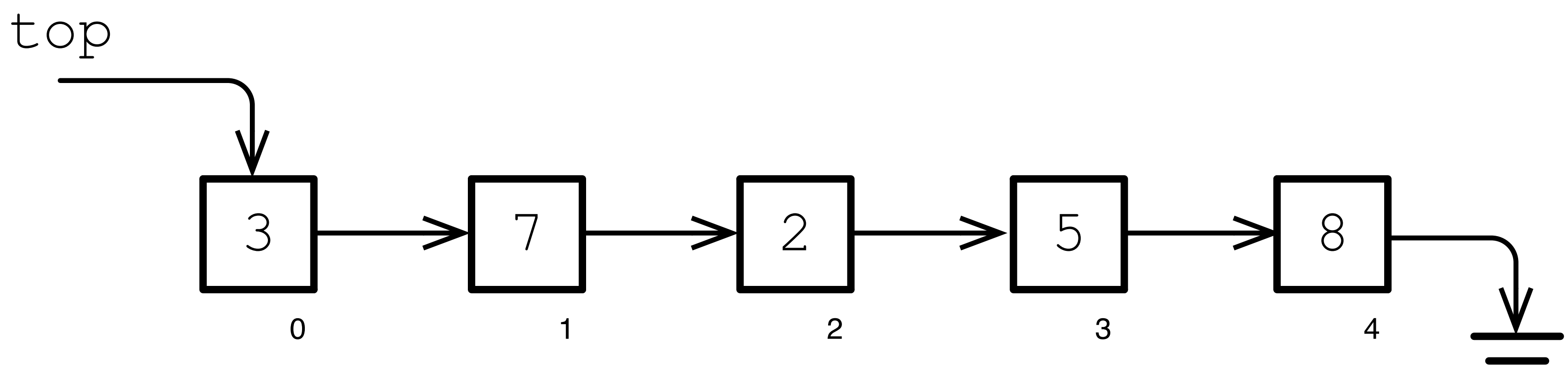


Another common operation is to **print** out the contents of the list. This is extremely helpful for debugging. It is similar to the size function in that we scan from the beginning to the end. But instead of counting nodes, we display each node's value.

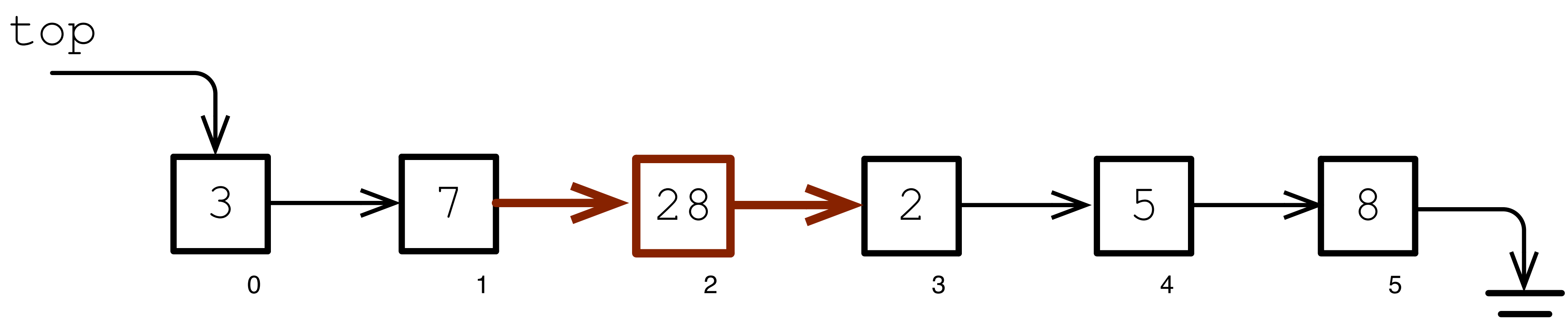
The list pointed to by 'top' would print out as:

3 7 2 5 0 8

Say we wanted to **insert** a value a particular index. Say we want to put the number 28 at index 2. This is what it looks like at the start:

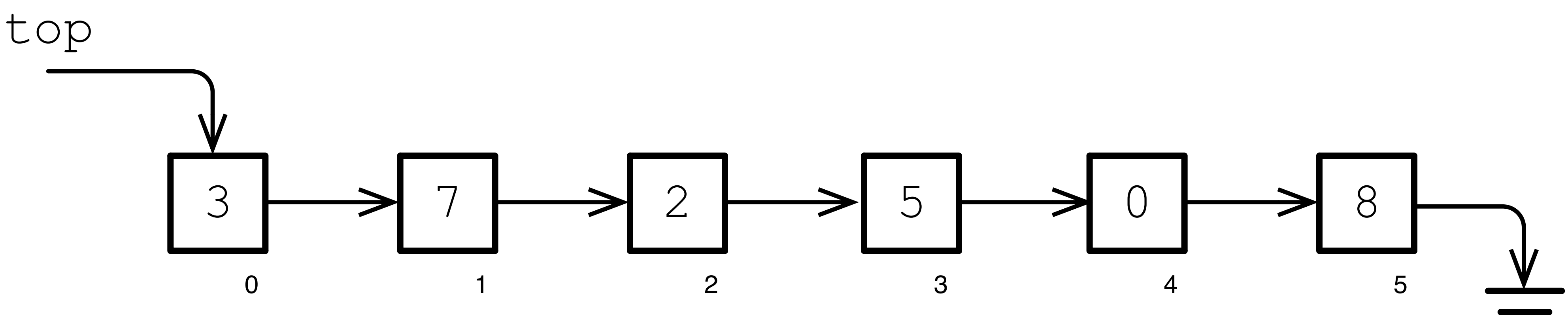


This is what we want it to look like at the end:

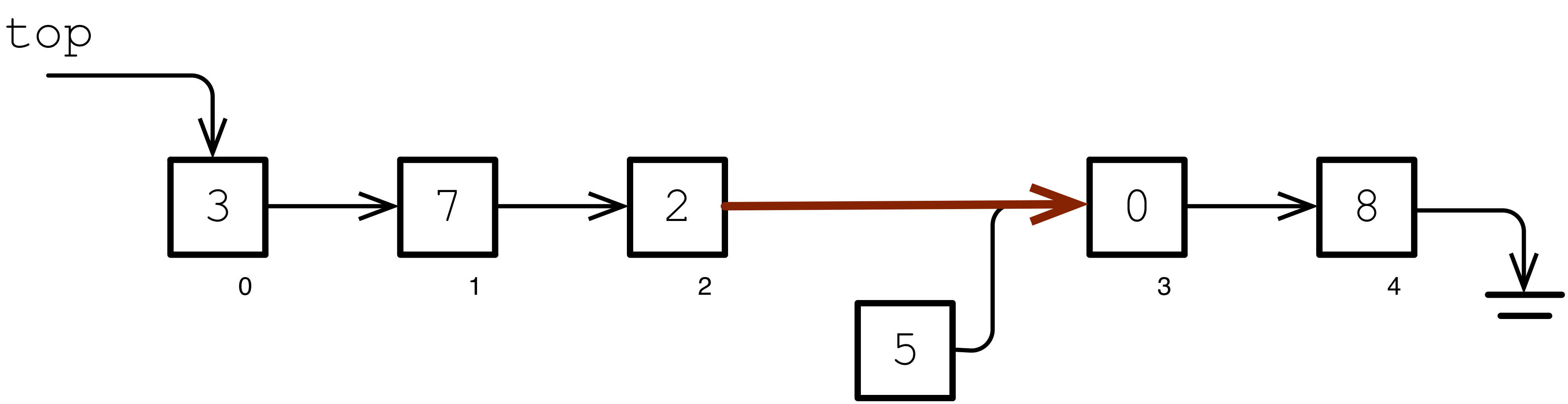


I've indicated the things that change: the link right before the new node, and the new node's link.

Say we wanted to **remove** a value a particular index. Say we want to remove the number 5 at index 3. This is what it looks like at the start:



This is what we want it to look like at the end:



Changed part indicated. Simply updated the preceding link to point beyond it. Note the '5' node persists.