DPST1091 / CPTG1391

Introduction to Programming

Week 10 Lecture 2

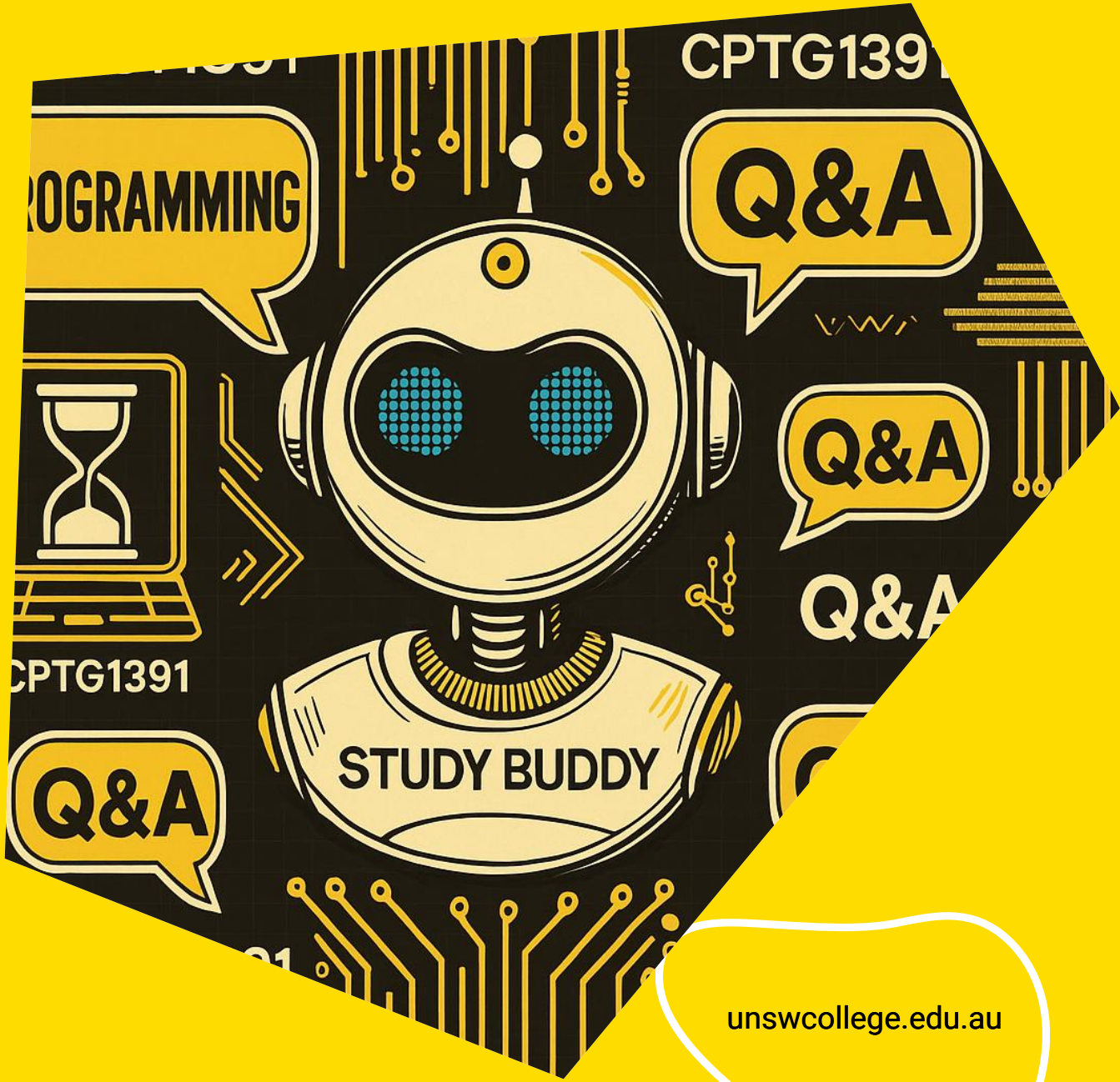
Lecturer and Course Convener:

Dr Pantea Aria

UNSW College

Linked Lists Functions

(part 2)



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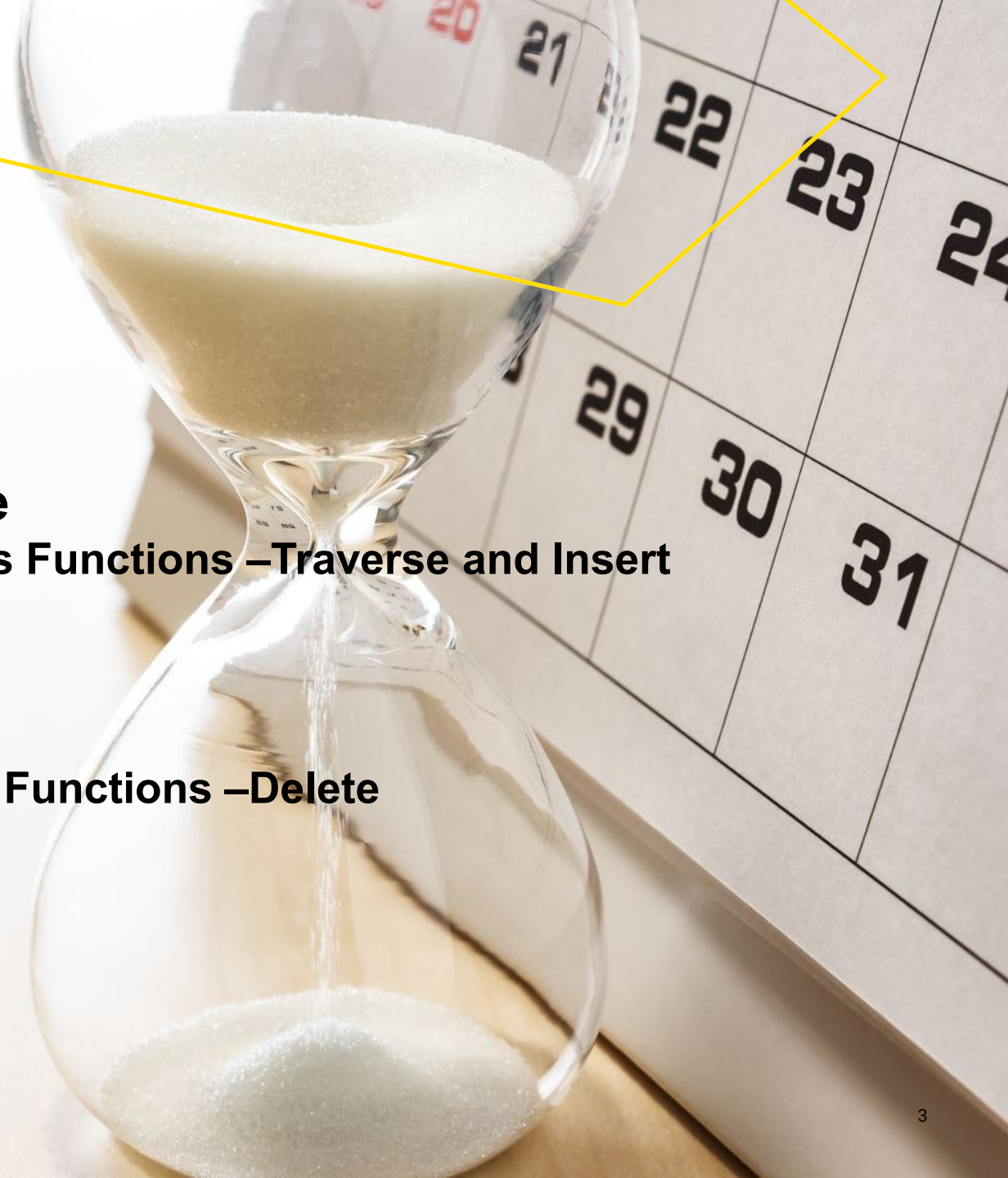
Agenda



- **Last lecture**
  - **Linked Lists Functions –Traverse and Insert**

- **Today**
  - **Linked Lists Functions –Delete**

Traversing a Linked List recap

First, we should set a **pointer to the beginning** of the list

```
struct node *current = head;
```

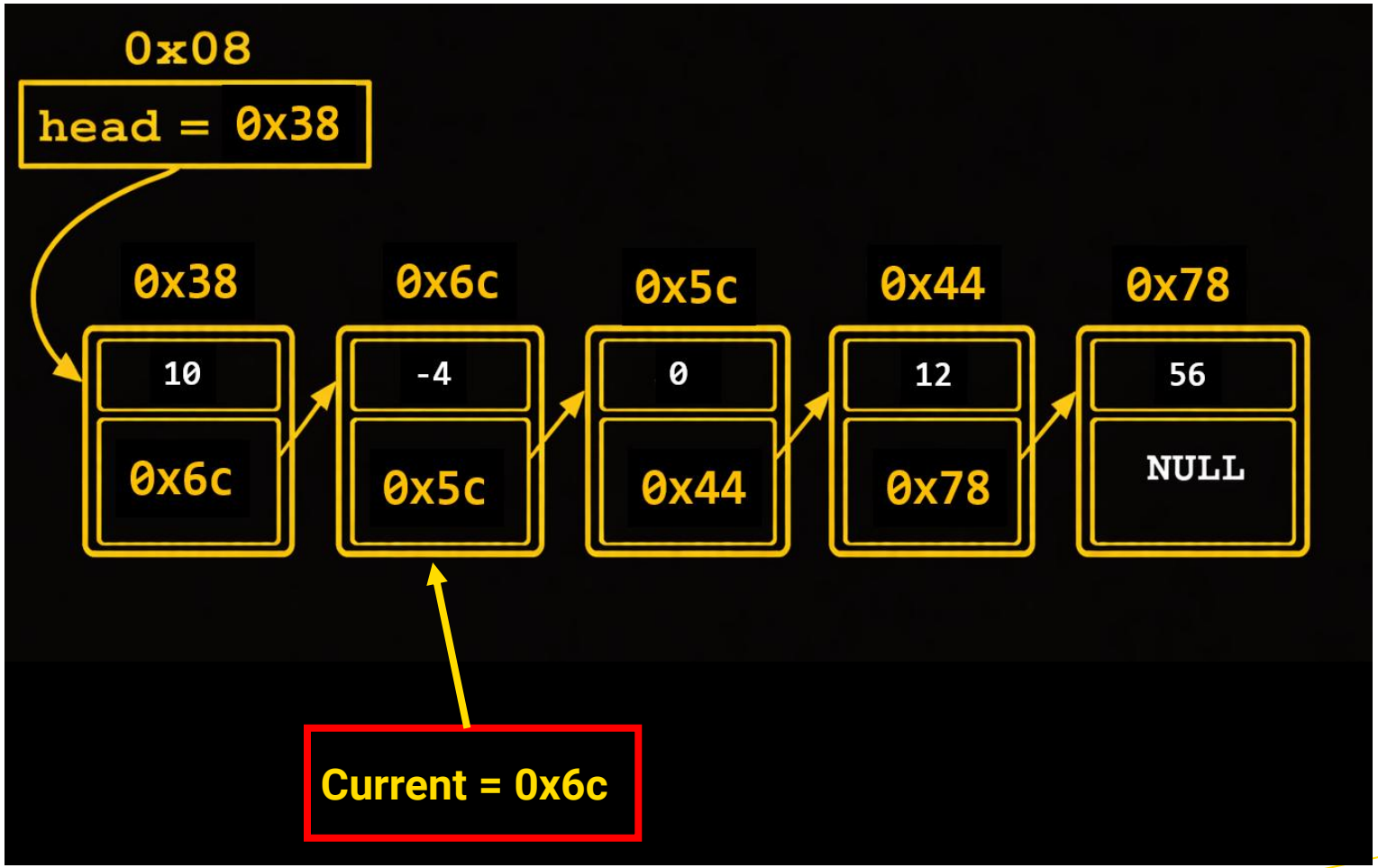
Traversing a Linked List

Then we should **move current** to the next nodes one by one

Traversing a Linked List

```
current = current->next;
```

Then we should **move current** to the next nodes one by one



Traversing a Linked List

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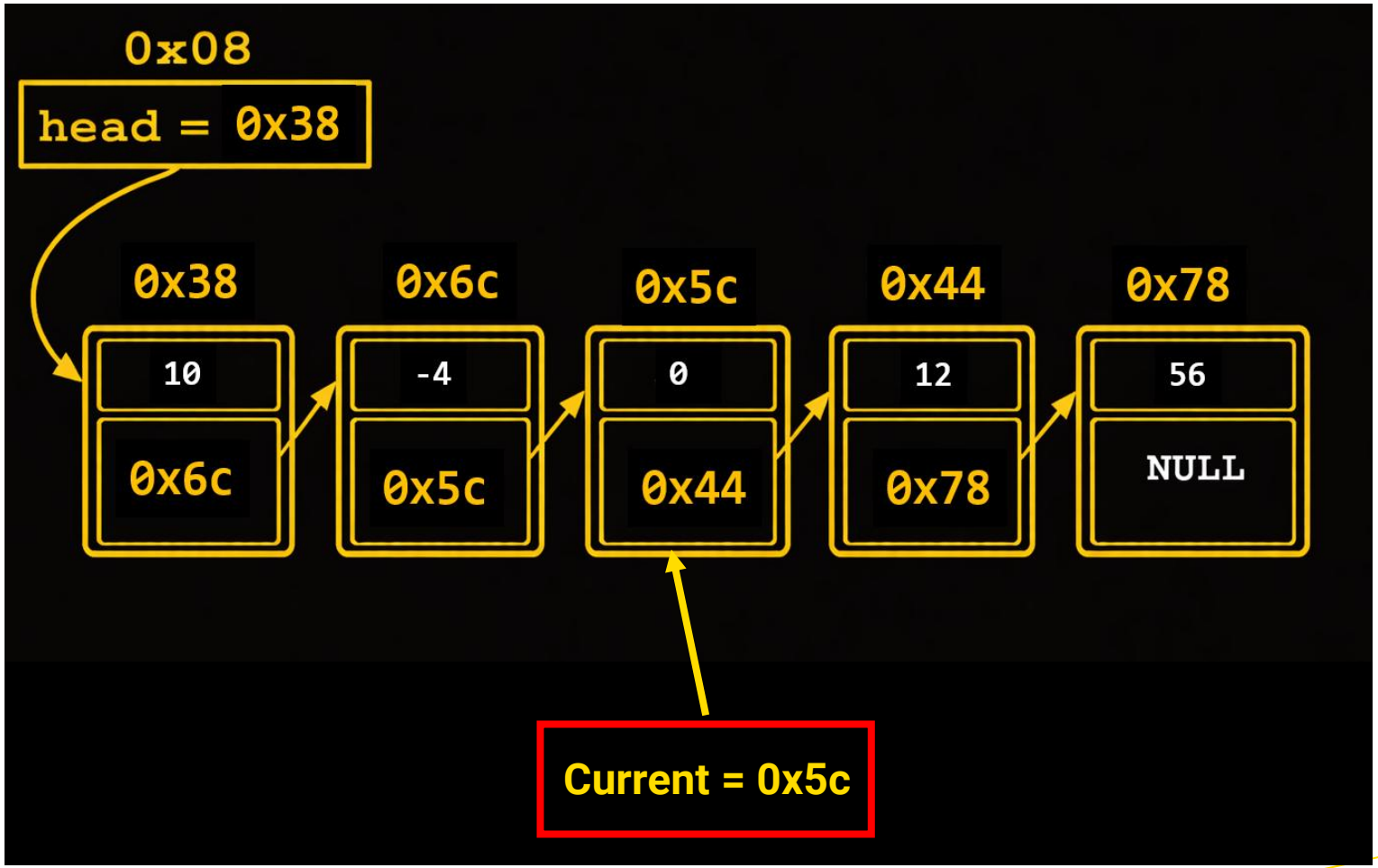

Traversing a Linked List

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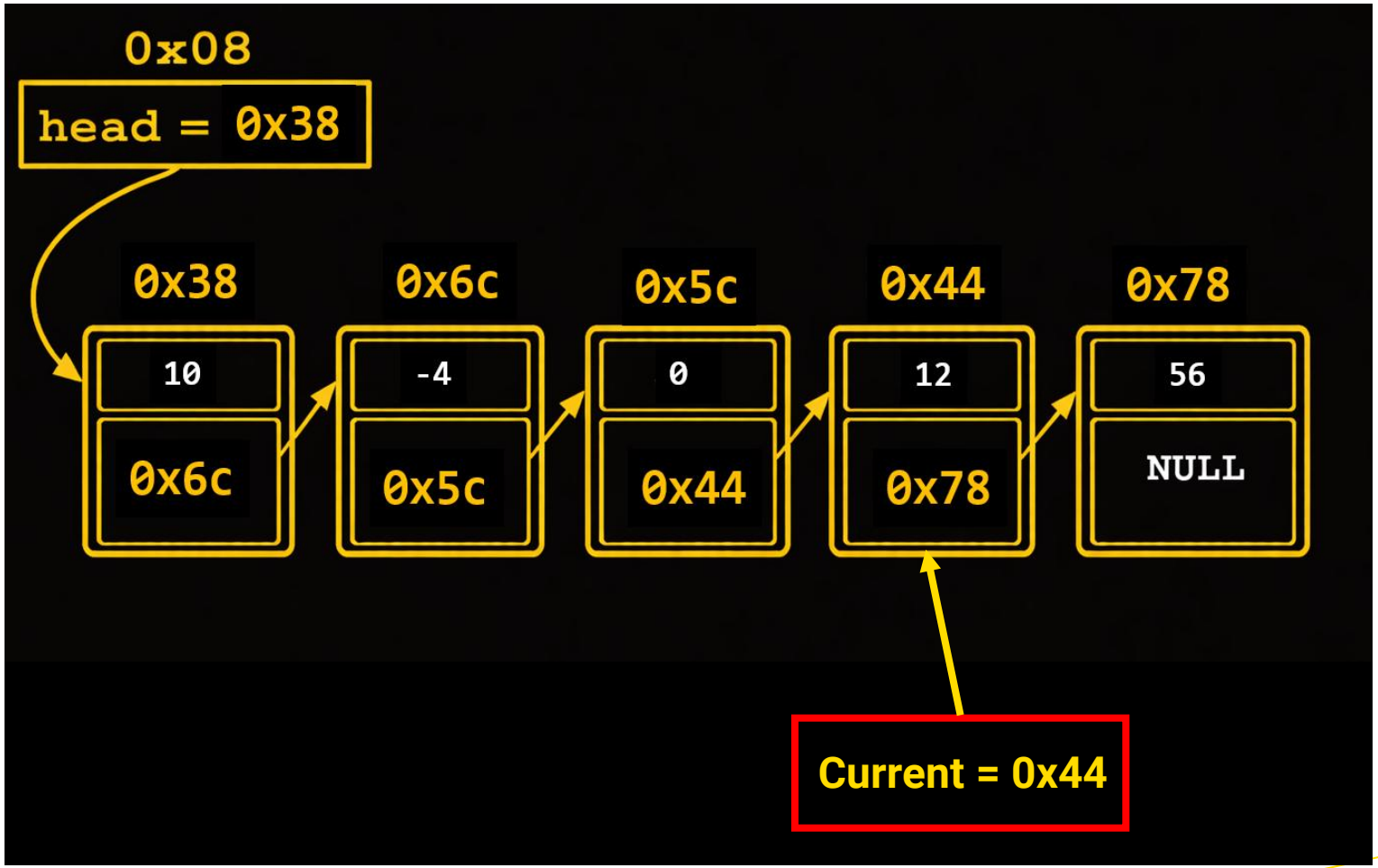


Traversing a Linked List

```
current = current->next;
```

Then we should **move current** to the next nodes one by one

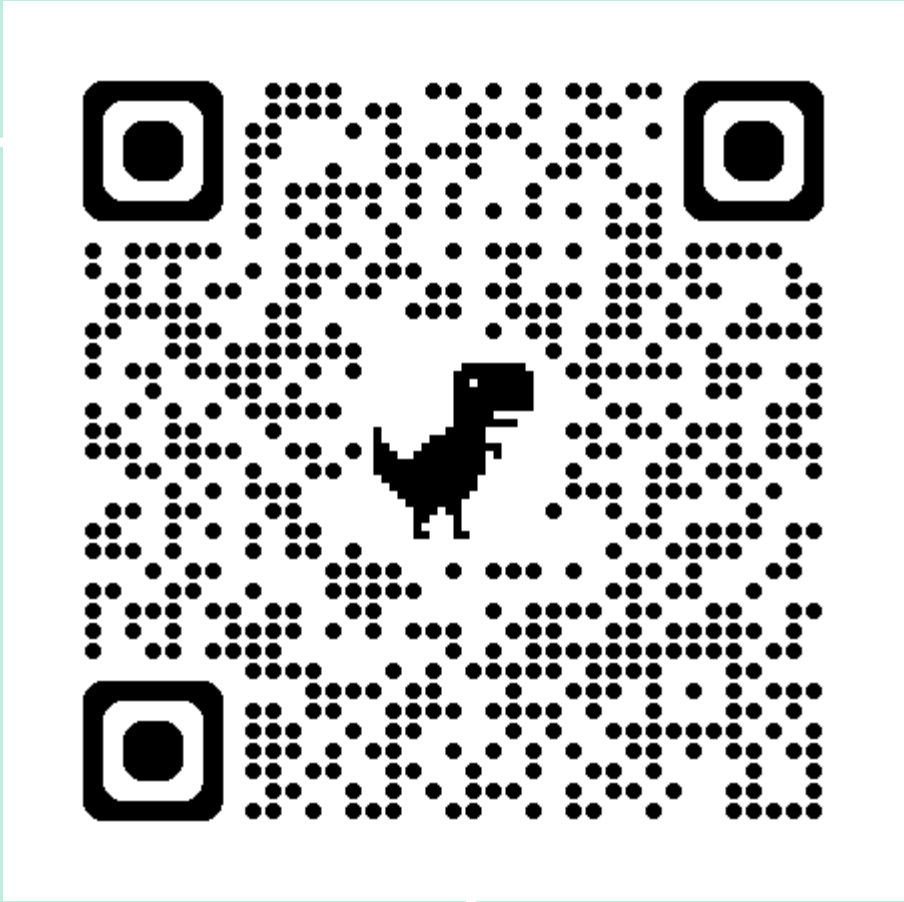
Traversing a Linked List

```
current = current->next;
```

We should **stop** when **current = NULL**

Demo

list_search_value.c



Live lecture code is written for teaching, not perfection.
It may include extra comments and may not always follow ideal coding style

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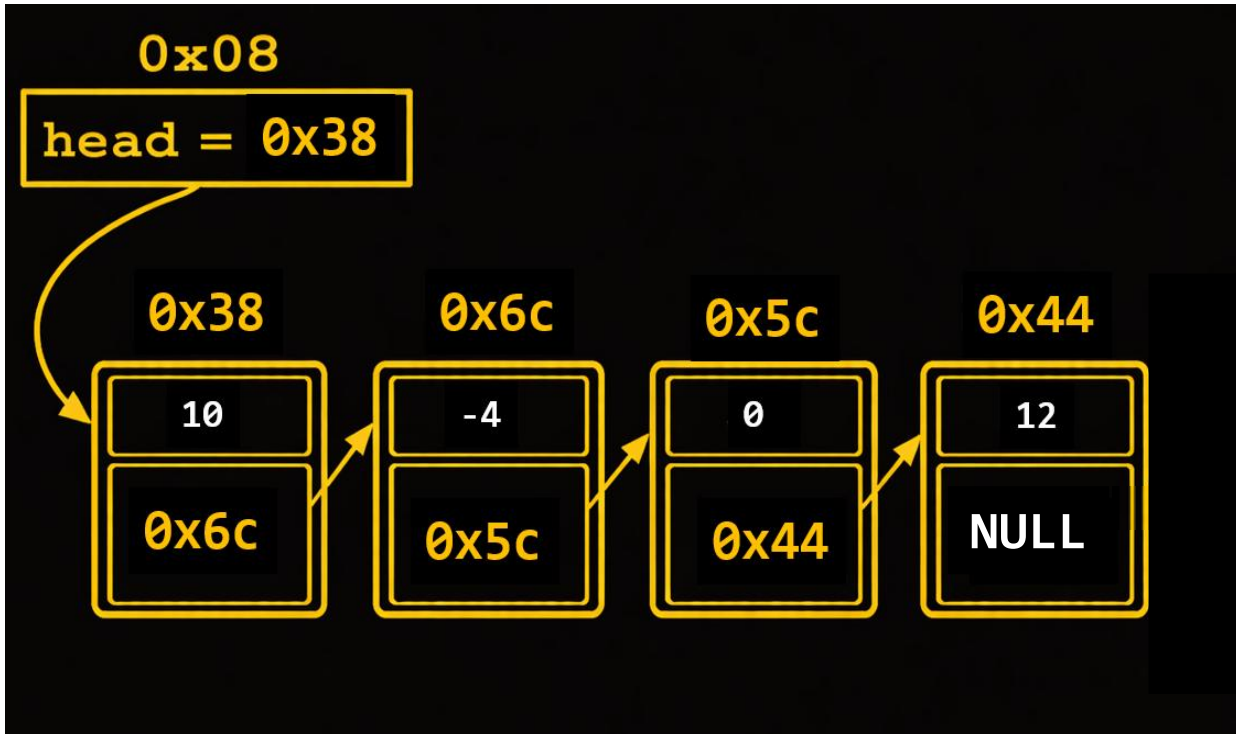
Inserting at a given position

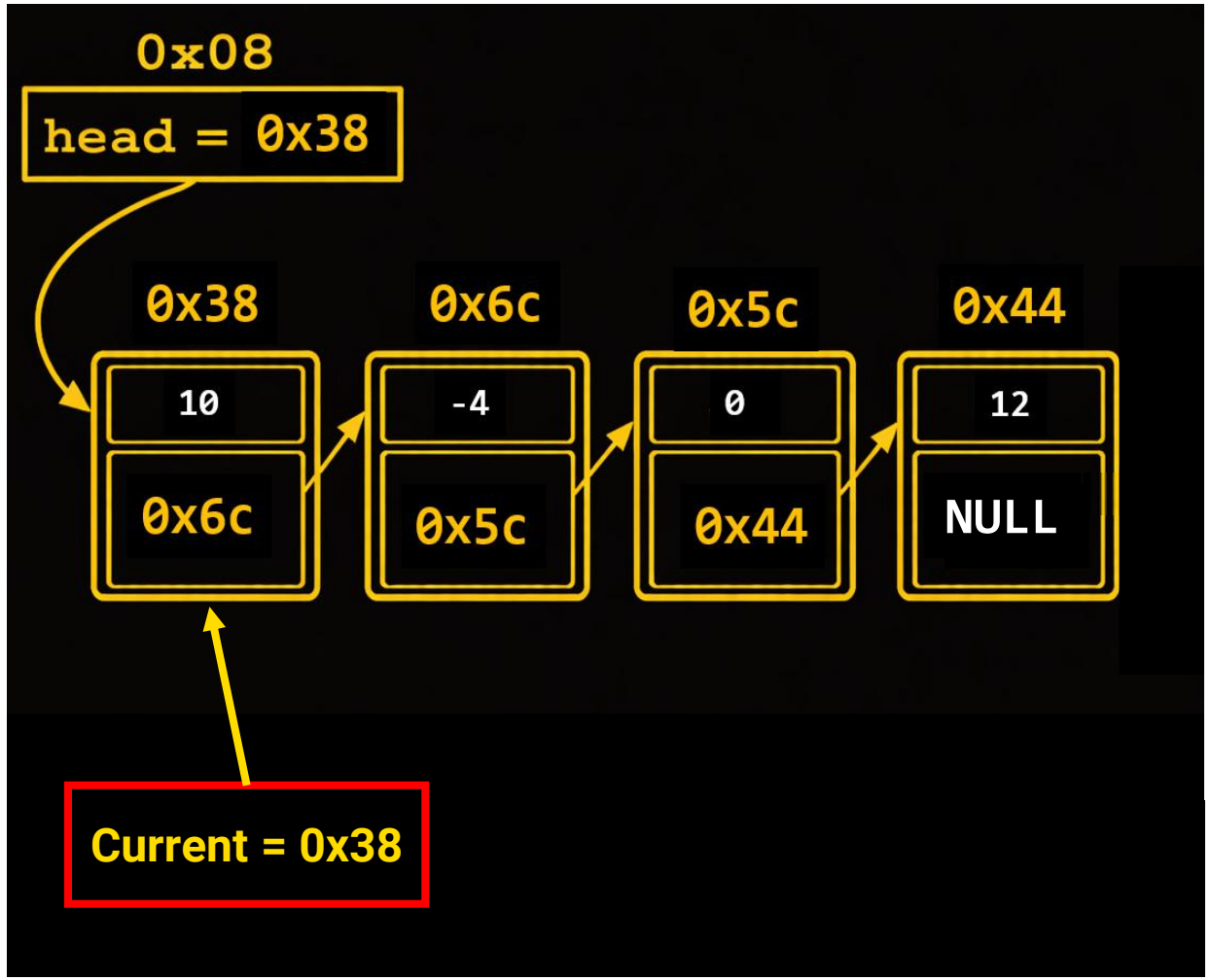
We want to **insert a new node** at the **position 2**, assuming positions **begin counting from 0**. In this example, that means the new node should be inserted at position 2.



This means, we should **use a counter** and **stop traversing** when we get to the node **before the position** we want to insert at **(position- 1).** In this case position 1.

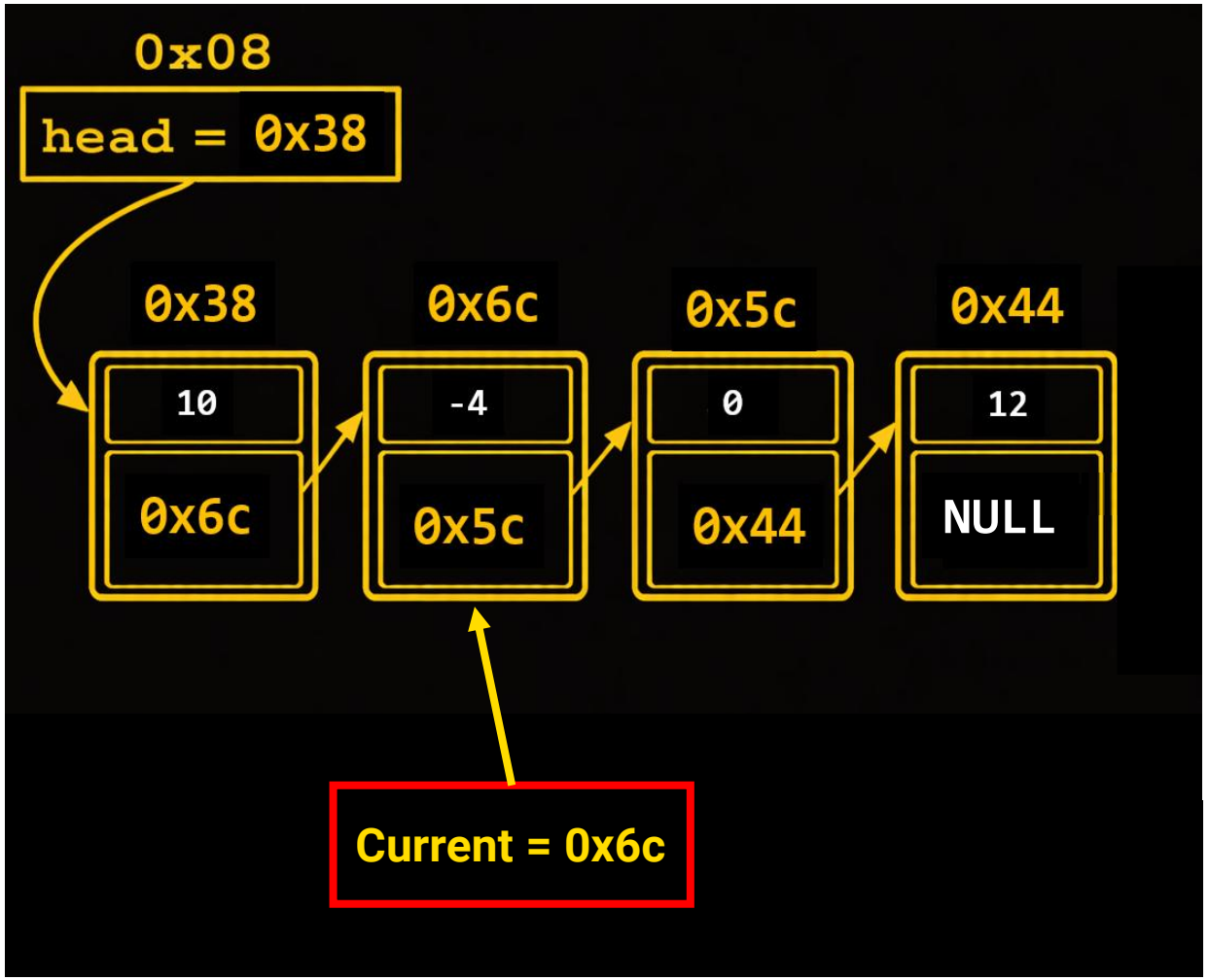
Inserting at Position

```
struct node *current = head;
int counter = 0;
```



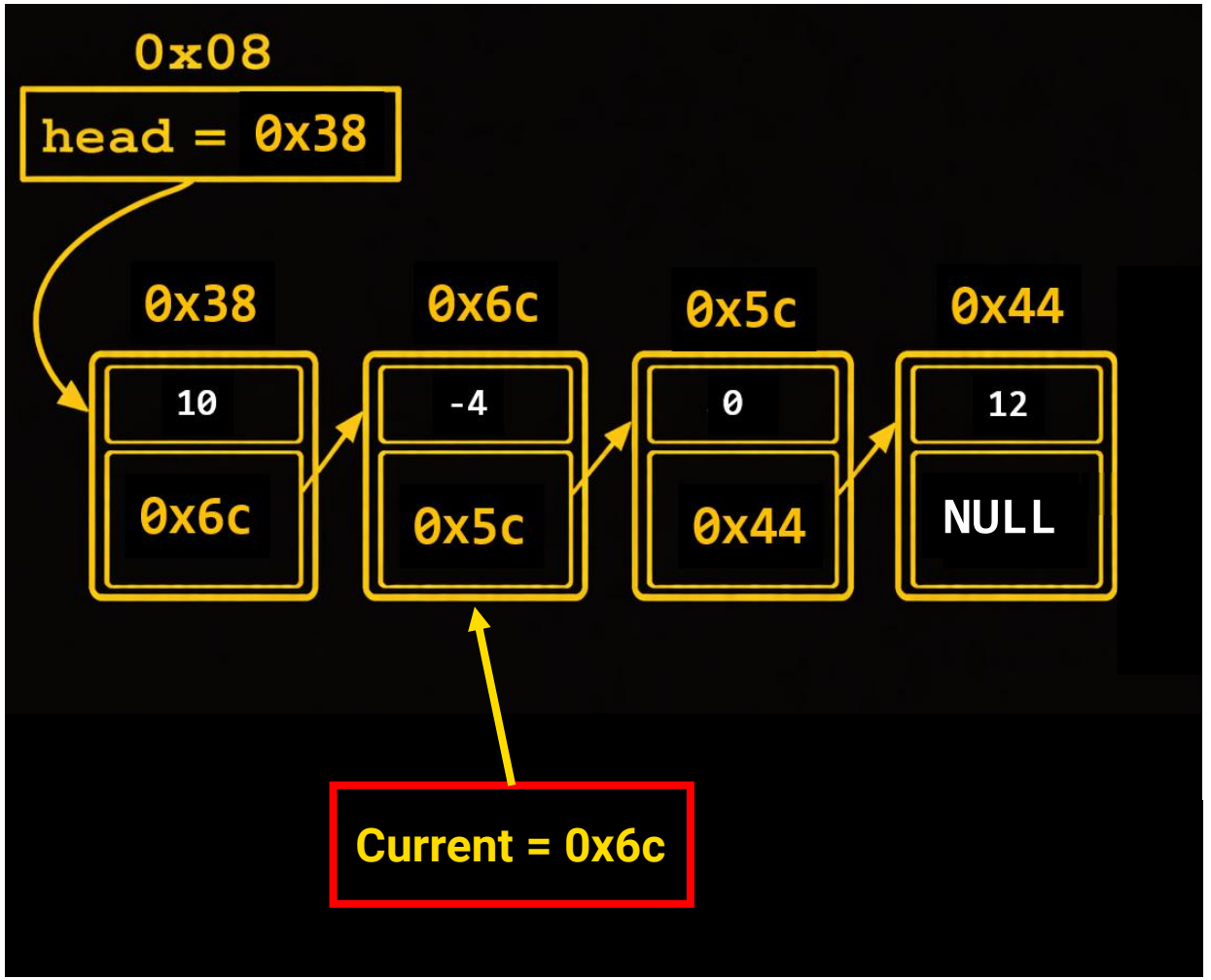
Inserting at Position

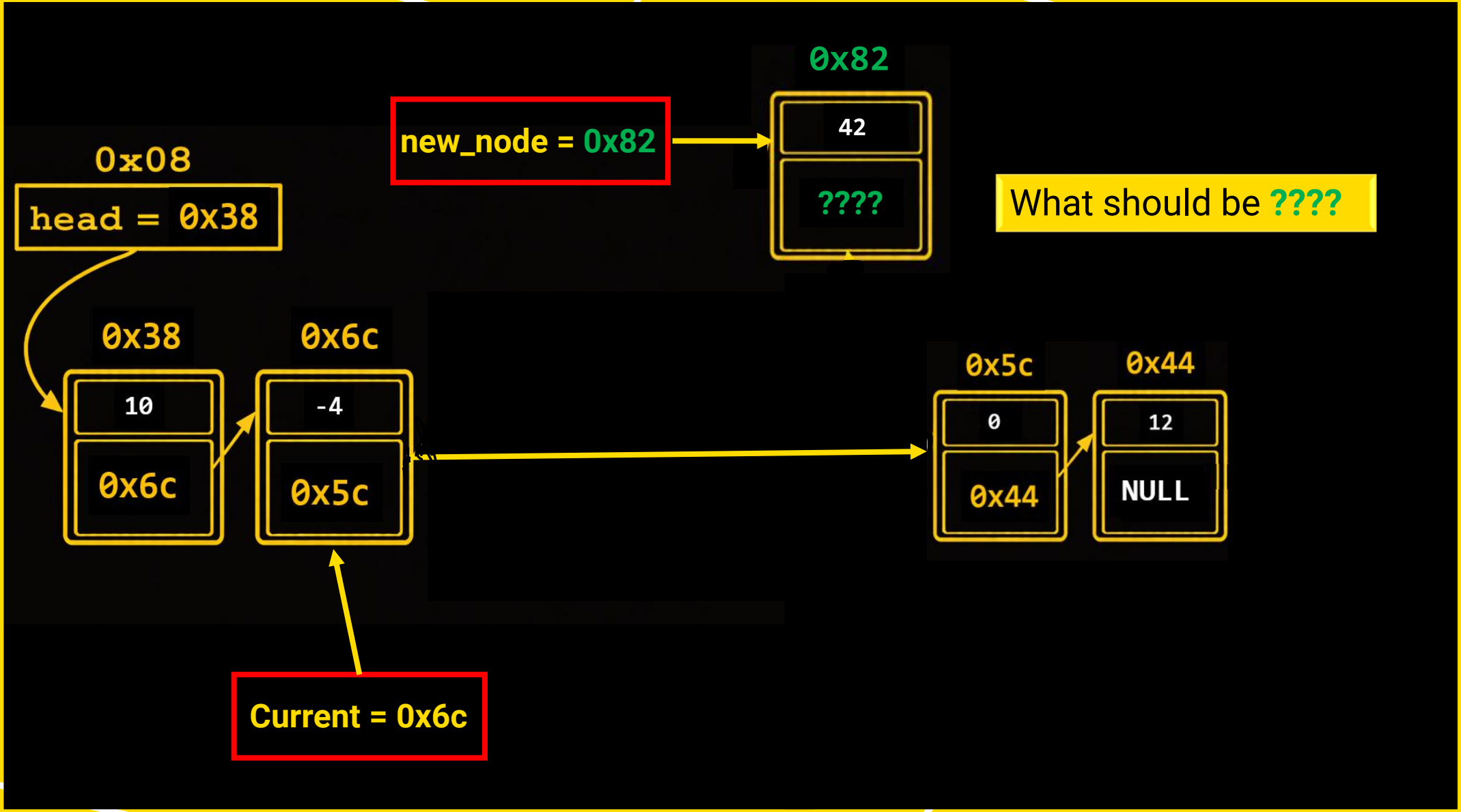
```
while (counter < position - 1) {
    current = current->next;
    counter++;
}
```



Inserting at Position

Now we want to connect our **new node**. It should come **after the current node**, but **before `current->next`**





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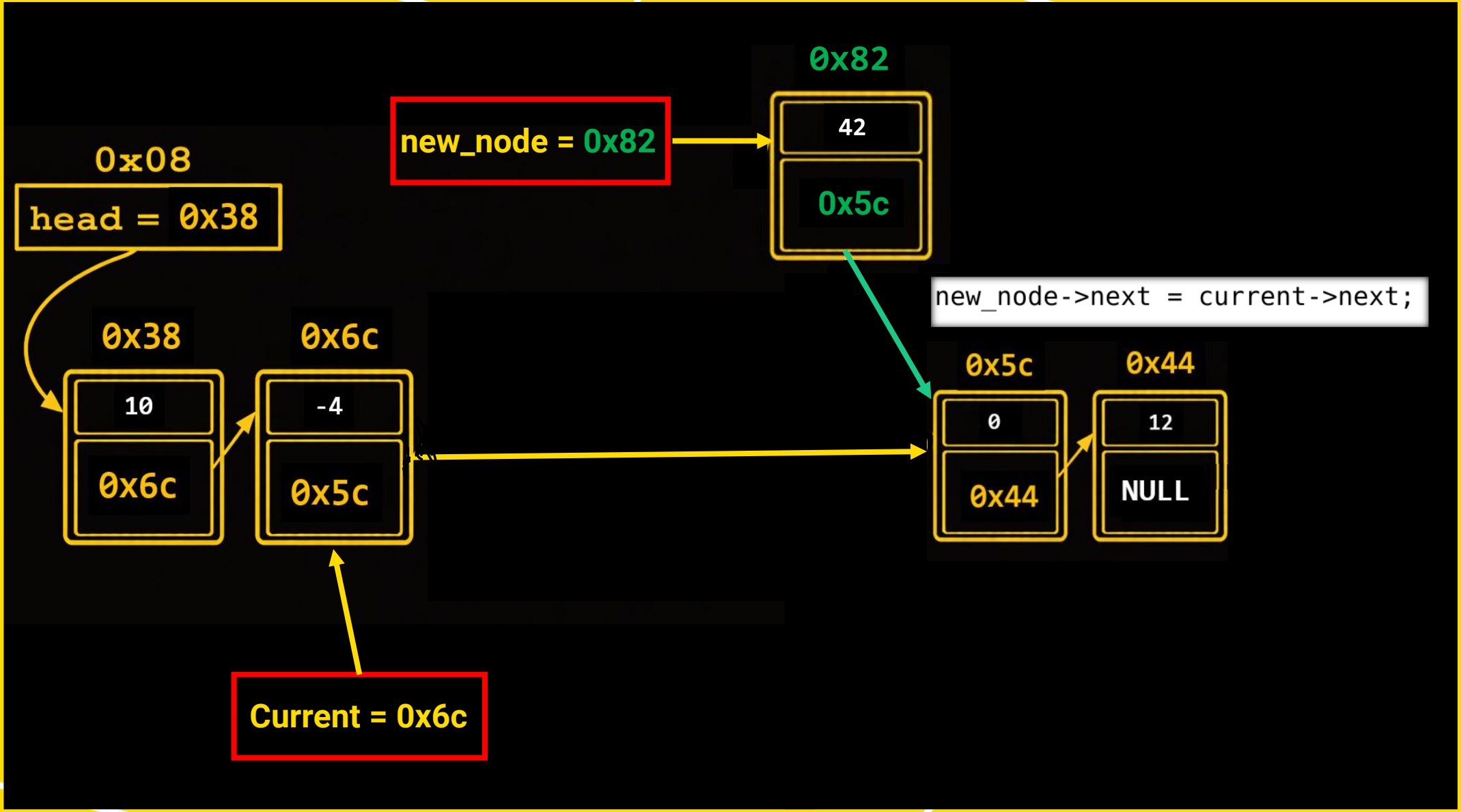
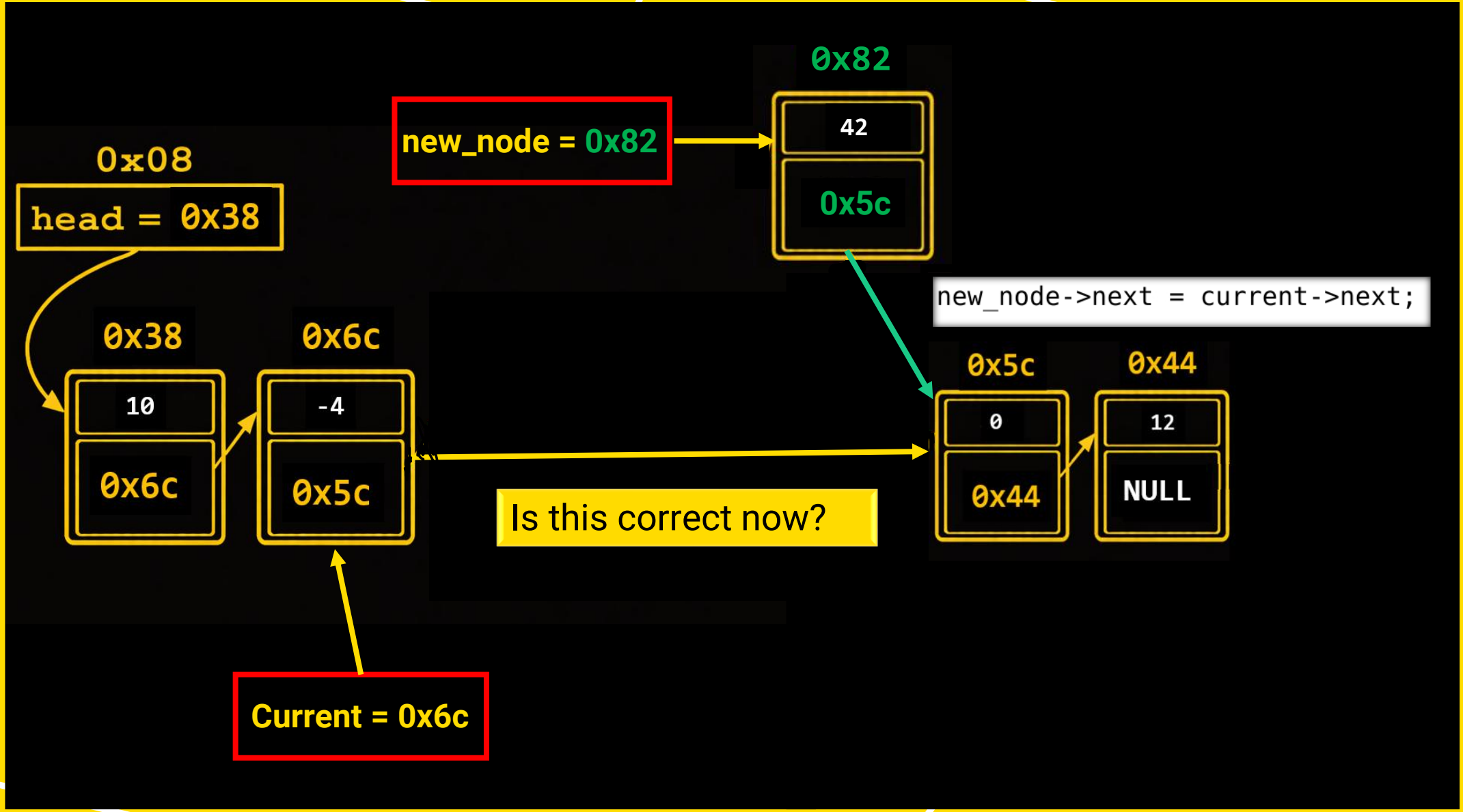

0x82
42
0x5c
new_node = 0x82
0x08
head = 0x38
new_node->next = current->next;
0x38
0x6c
10
0x6c
-4
0x5c
0x5c
0x44
0
0x44
12
NULL
Current = 0x6c


0x82
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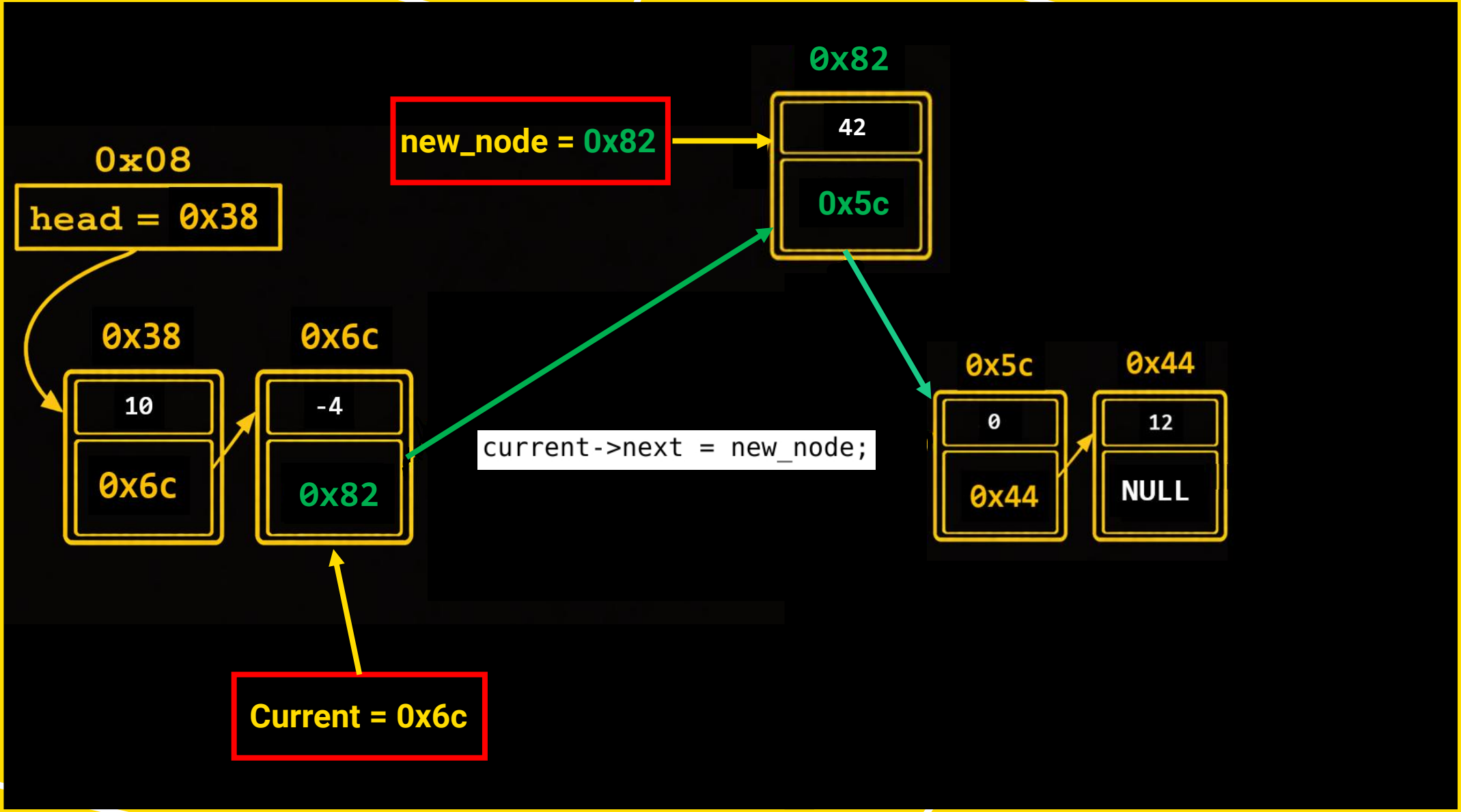
0x38
0x6c
10
0x6c
-4
0x5c
0x5c
0x44
0
0x44
12
NULL
Is this correct now?
Current = 0x6c


0x82
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current->next = new_node;
0x5c
0
0x44
0x44
12
NULL
Current = 0x6c

What would be the insert coding issues?

What conditions will break this?

- What happens if it is an **empty list**?
- What happens if there is **only 1 item** in the list?
- **Anything else** we should check?

How can we modify our code to handle any of these situations that break it?

Inserting Into a Linked List Test Cases

Draw a diagram!!!

- Inserting into an **empty list**
- Inserting at the **beginning** (**head**) of the list
- Inserting **after the first node** when there is only one node
- Inserting **somewhere in the middle** of the list
- Inserting **at the end** of the list

Deletion

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Deleting the First Node in a Linked List

We must first check whether the list is **empty**

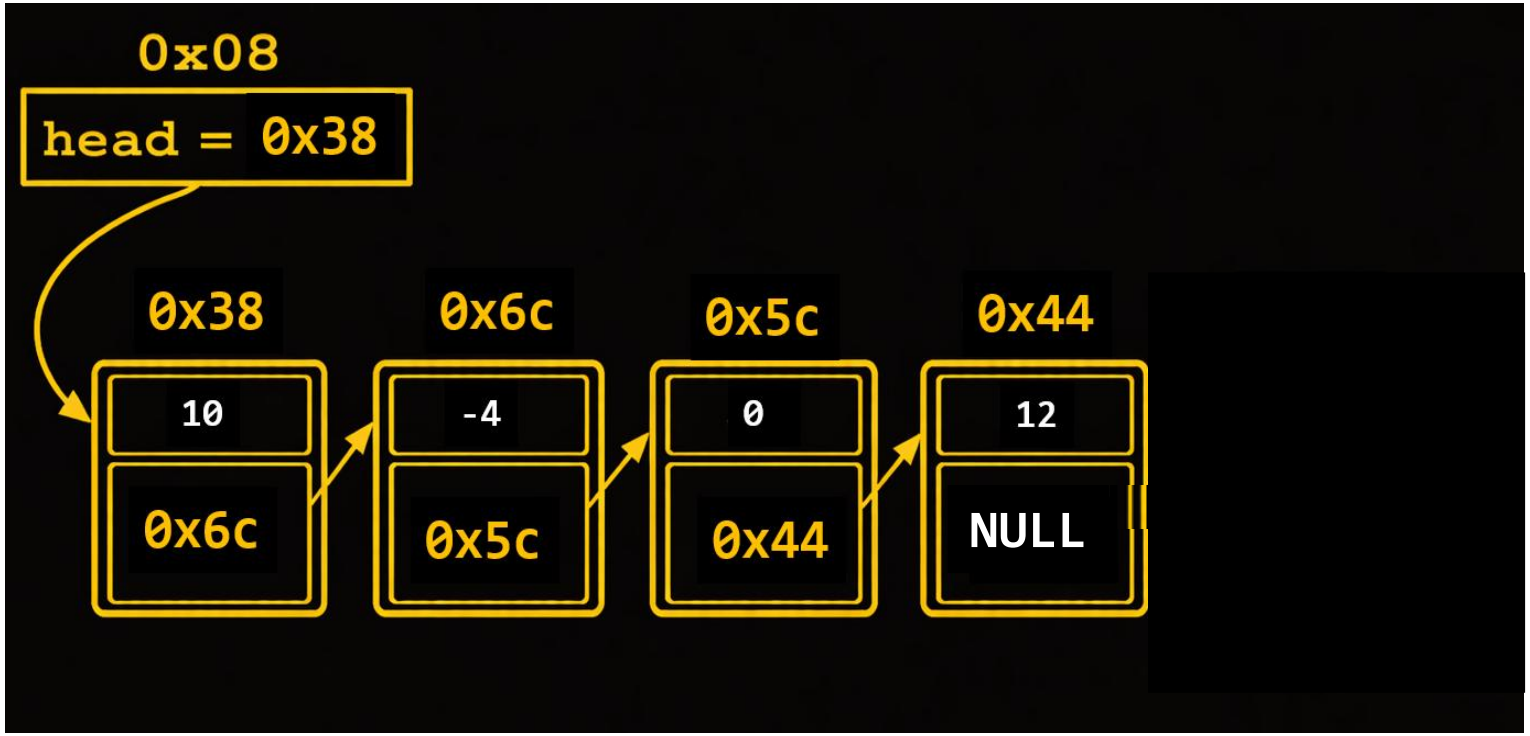
If the list is empty, there is no node to remove.

In that case, we simply return the head pointer, which will be NULL.

```
if (head == NULL) {

    return head;
    //or return NULL;

}
```

Deleting the First Node in a Linked List

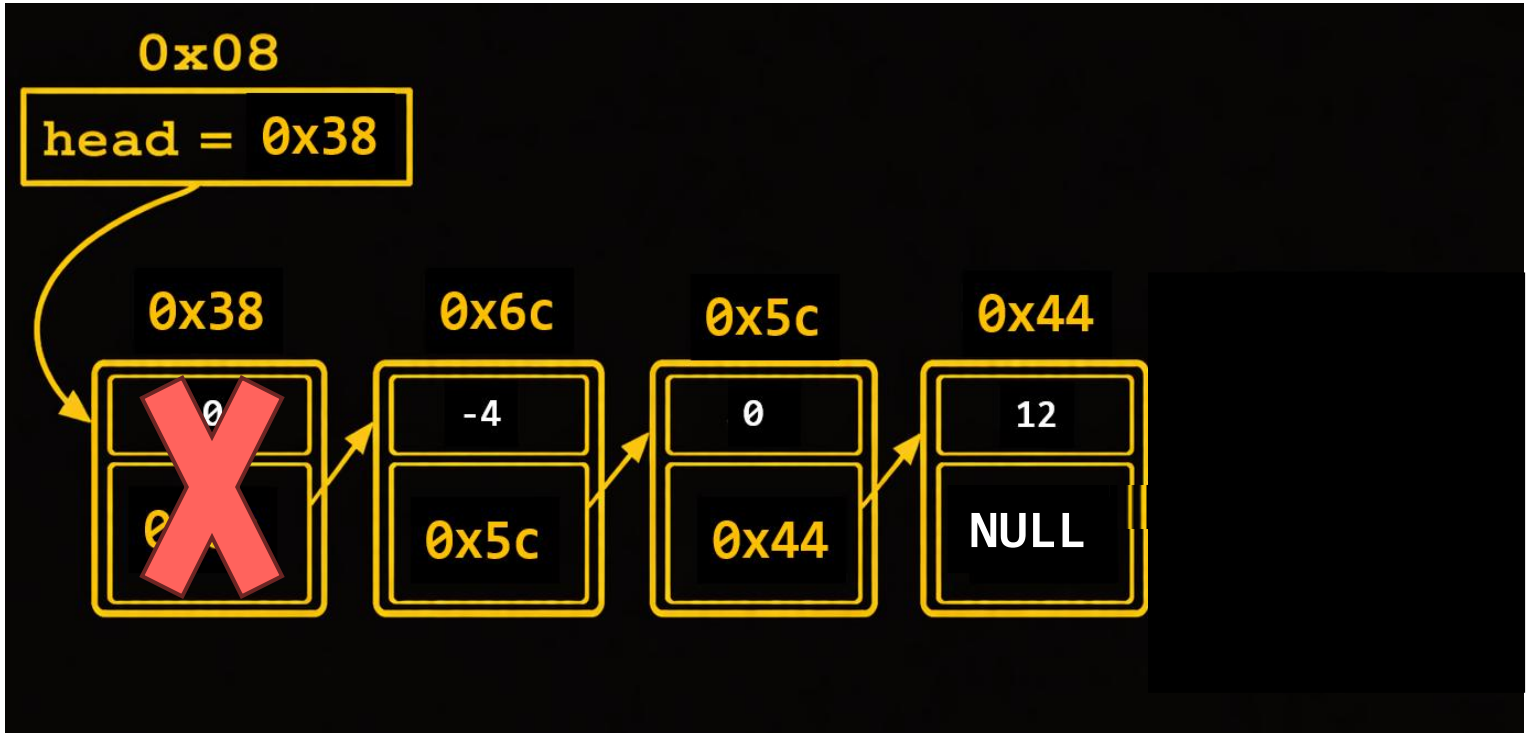
If our list is not empty, we want to make the second node the new head of the list and free the first node that we want to delete.



Deleting the First Node in a Linked List

What **issue** would arise if we called free on the head node **before updating the head pointer**?

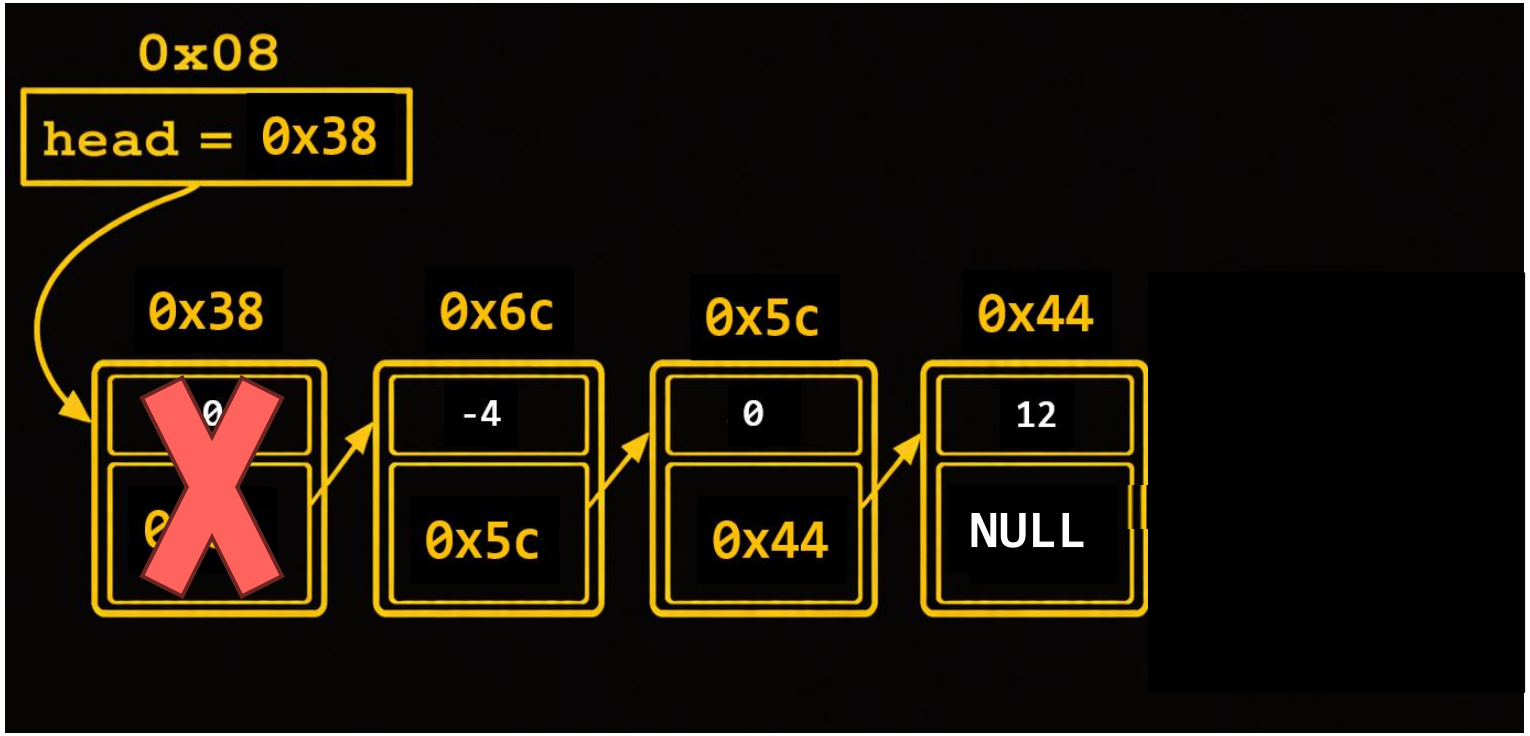
```
free(head);
```



Deleting the First Node in a Linked List

Once memory **has been freed**, we **can no longer access** it. As a result, we **lose access** to the rest of the list.

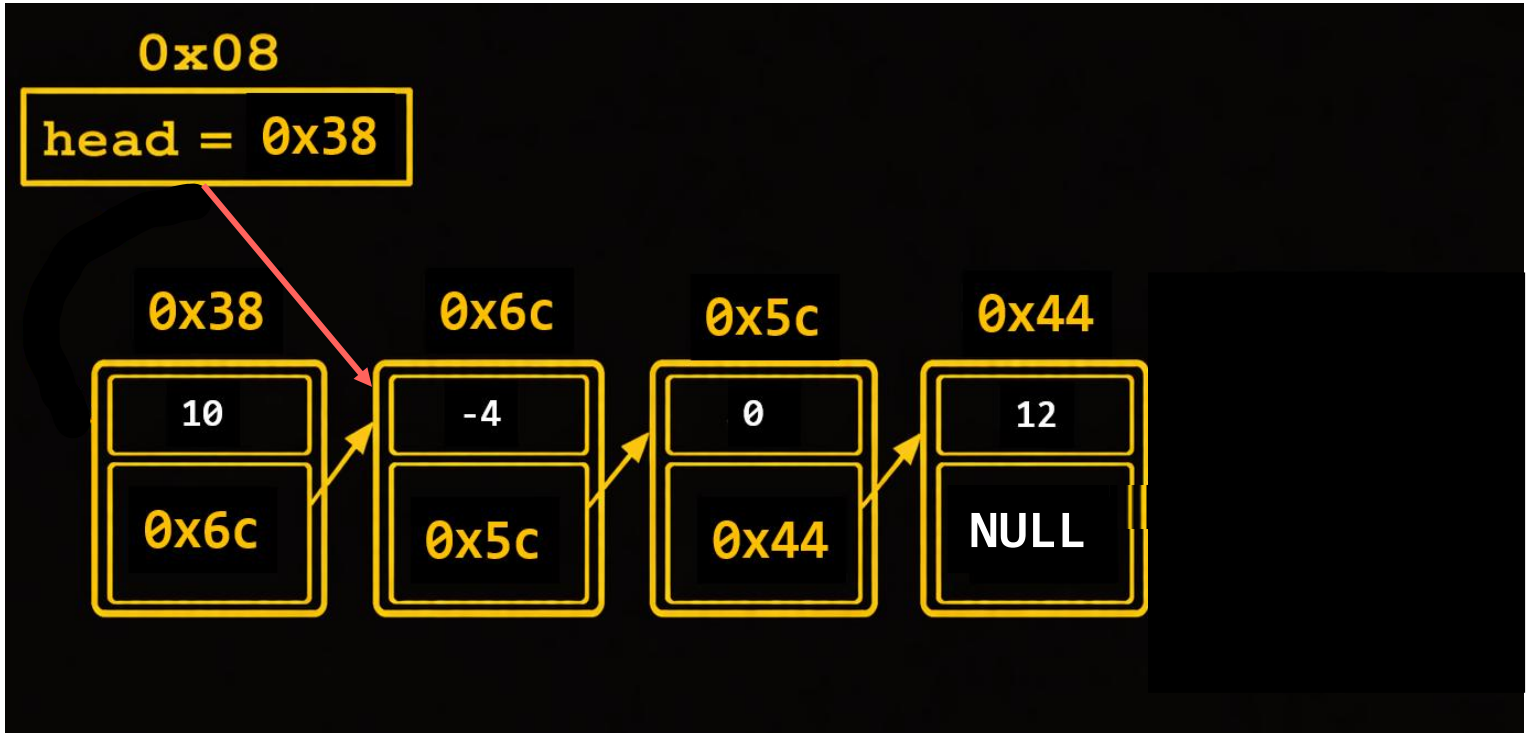
```
// This will crash
head = head->next;
```



Deleting the First Node in a Linked List

What problem could occur if we update the head pointer before handling the original first node properly?

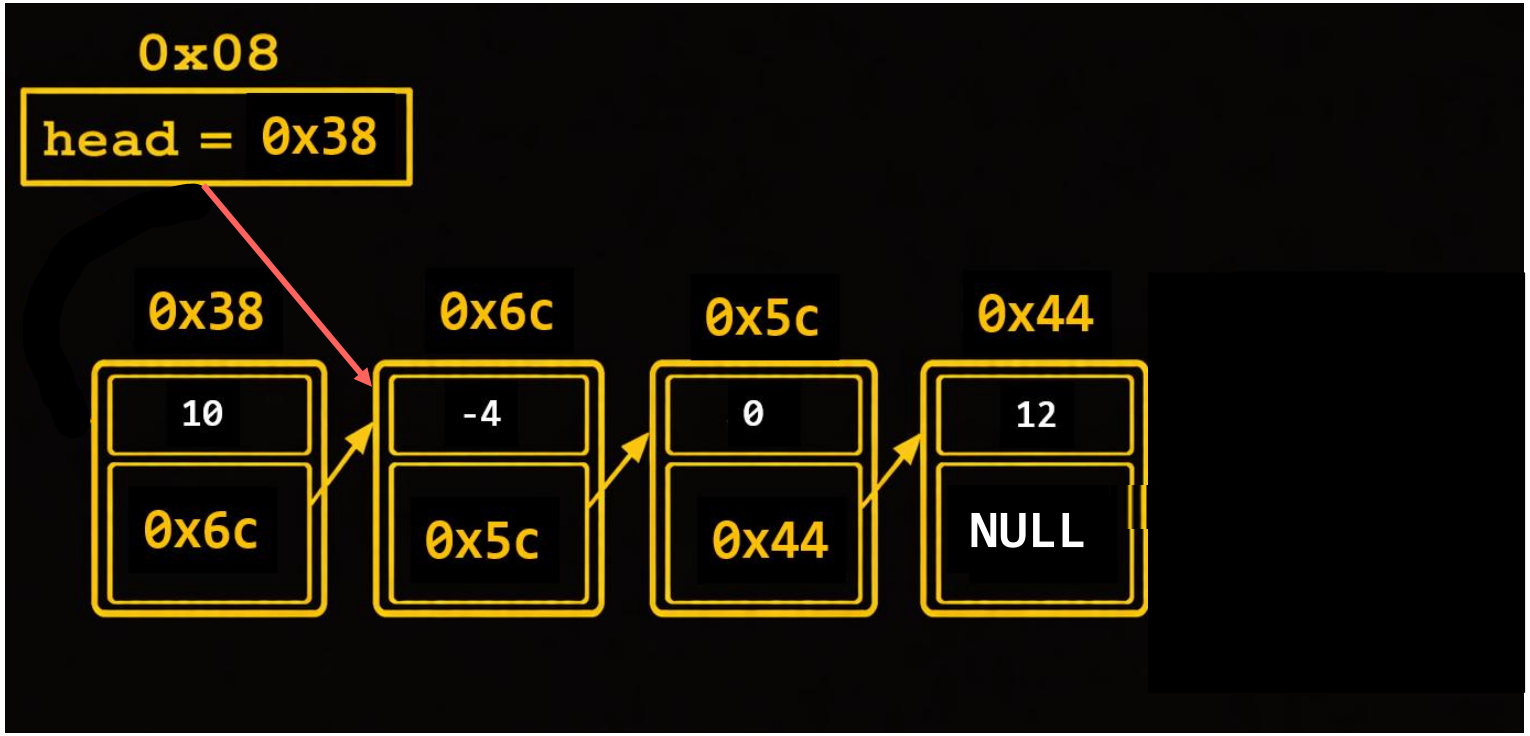
```
head = head->next;
```



Deleting the First Node in a Linked List

We no longer have a pointer to the first node, so there is **no way to free** its memory.

```
free(???);
```



Deleting the First Node in a Linked List

Let's introduce a separate pointer that refers to the first node.

```
struct node *temporary = head;
```

Deleting the First Node in a Linked List

Now we can safely update the head pointer.

```
head = head->next;
```

Deleting the First Node in a Linked List

Now we can safely free the memory allocated to the first node.

```
free(temporary);
```

Deleting the First Node in a Linked List

```
struct node *delete_first_node(struct node *head) {

    if (head == NULL) {
        return head;
    }

    struct node *temporary = head;
    head = head->next;
    free(temporary);
    return head;

}
```

Deleting All Nodes

Wrong way

Is this code correct?

```
// Delete all nodes from a given list
void delete_all_nodes(struct node *head) {

    struct node *current = head;
    while (current != NULL) {
        free(current);
        current = current->next;

    }
}
```

Deleting All Nodes

Wrong way

Remember, once you free a block of memory, **it must no longer be accessed or used**.

```
// Delete all nodes from a given list
void delete_all_nodes(struct node *head) {

    struct node *current = head;
    while (current != NULL) {
        free(current);
        // Accessing memory that has already been freed
        current = current->next;

    }
}
```

Deleting All Nodes

Correct way

Let's test it and check it with
`dcc -leak-check`

```c
// Delete all nodes from a given list
void delete_all_nodes(struct node *head) {

    struct node *current = head;

    while (current != NULL) {
        head = head->next;
        free(current);
        current = head;
    }

}
```

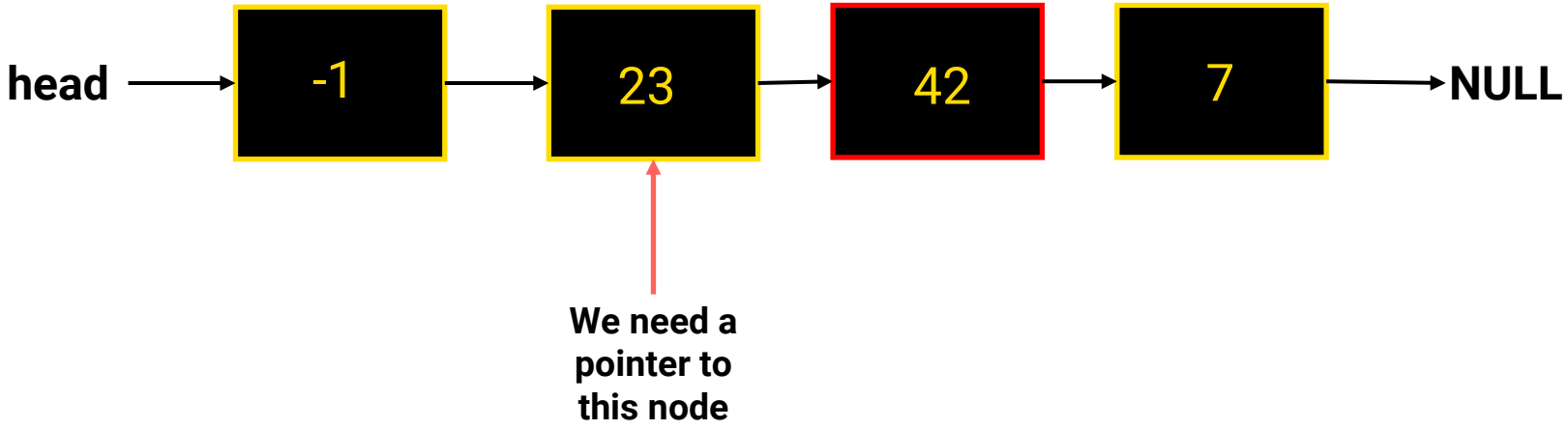
Search and Delete

We want to find a node that contains a specific value and then remove it from the list. Where might this node be located?

- It might **not exist** at all, either the **list is empty** or the **value is not present.**
- It could be **at the head**, meaning we need to **delete the first node**.
- It could be somewhere **in the middle**, **between two nodes.**
- It could be **at the tail**, meaning we **remove the last node.**
- The value might appear **more than once**. For now, we will only focus on deleting the first occurrence.

Search and delete between 2 nodes

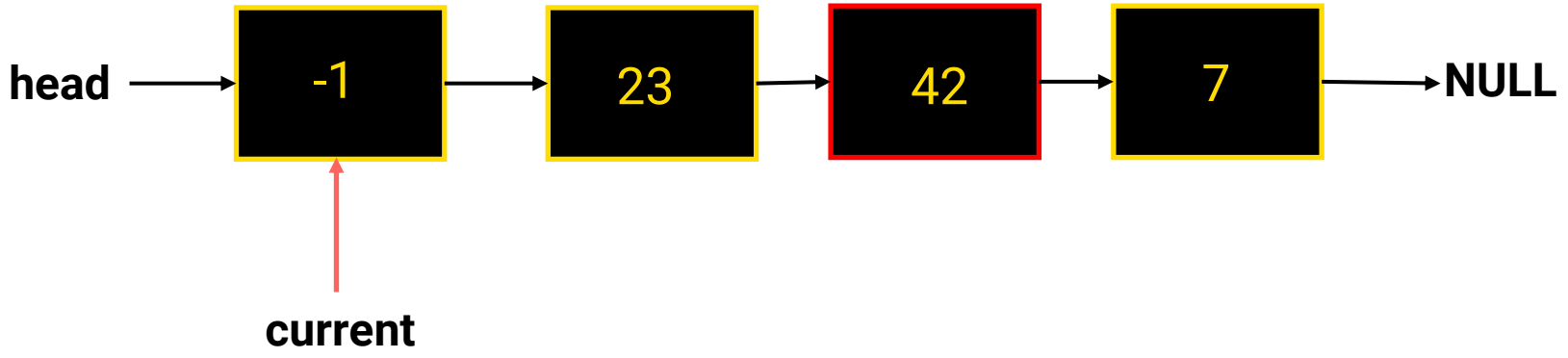
To delete a node, we must **connect the previous node directly to the next node**; so, if we want to remove the node containing 42, we first need to **locate the node that comes before it**.



Search and delete between 2 nodes

Method 1

```c
// Method 1:
// Use two pointers while traversing the list:
// - 'current' moves through each node to find the target value.
// - 'previous' keeps track of the node before 'current'.
// This allows us to relink nodes properly when deleting.

struct node *previous = NULL;
struct node *current = head;

// Traverse the list until:
// 1. We reach the end (current == NULL), or
// 2. We find the node containing search_key.

while (current != NULL && current->data != search_key) {

    previous = current;      // Move previous forward
    current = current->next; // Move current forward

}
```



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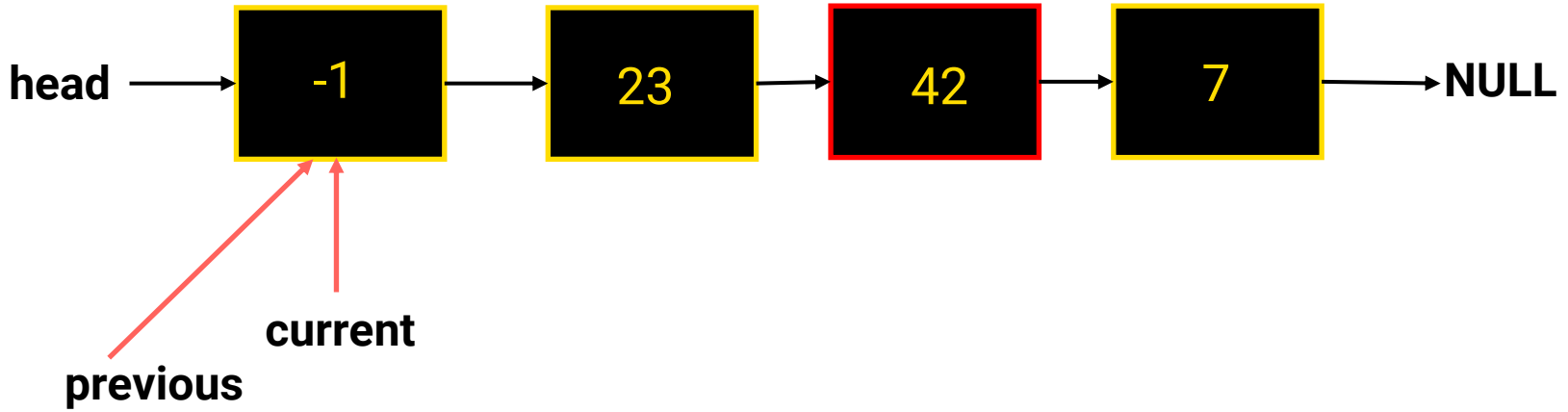

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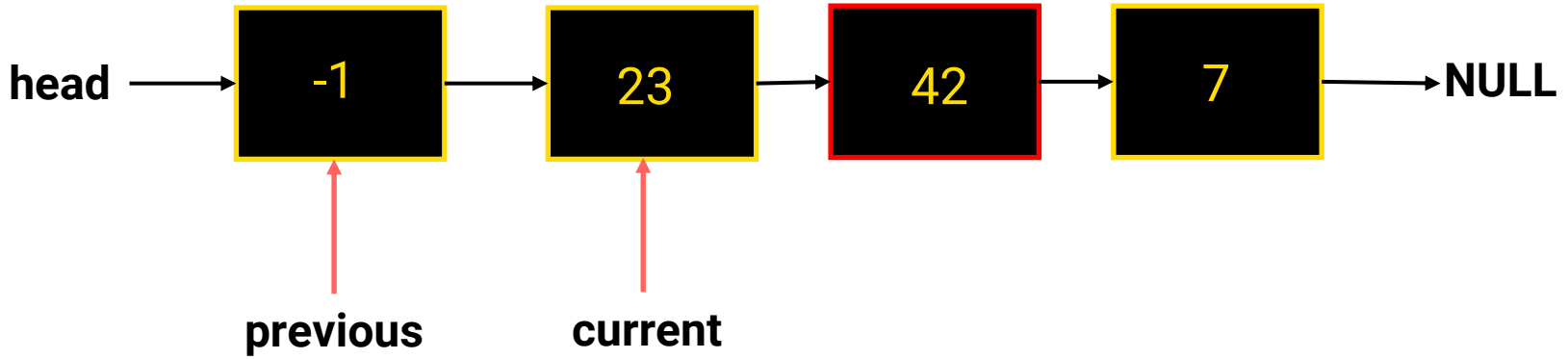

Search and delete between 2 nodes

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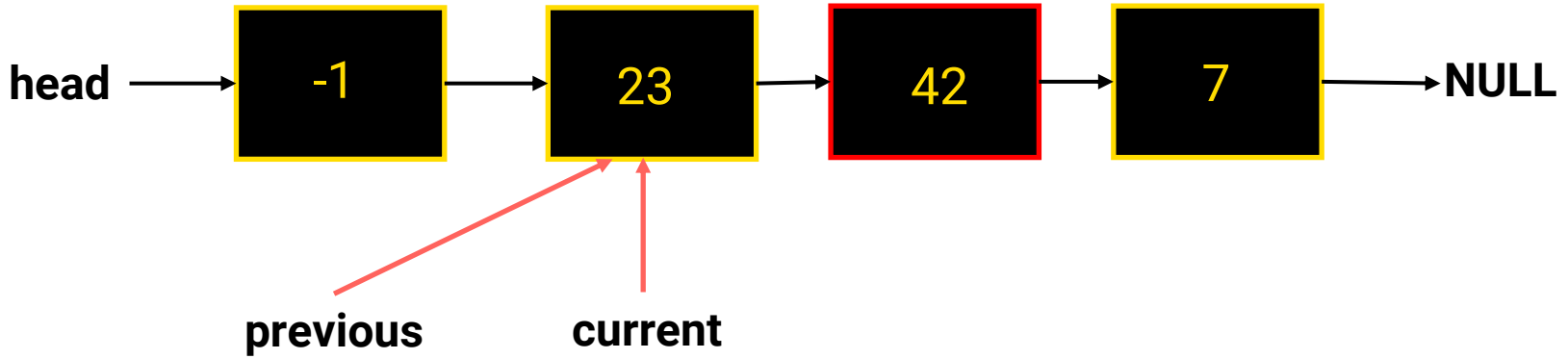

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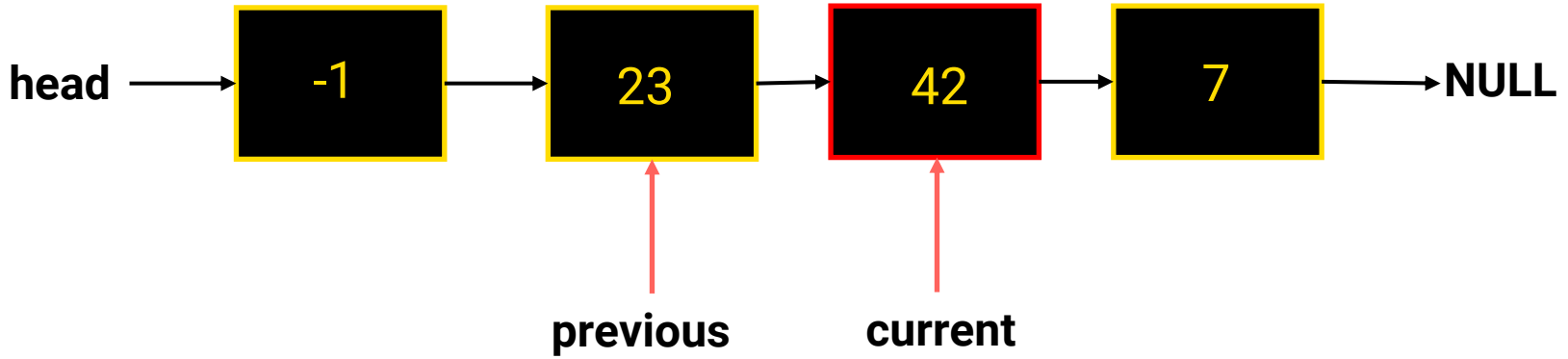
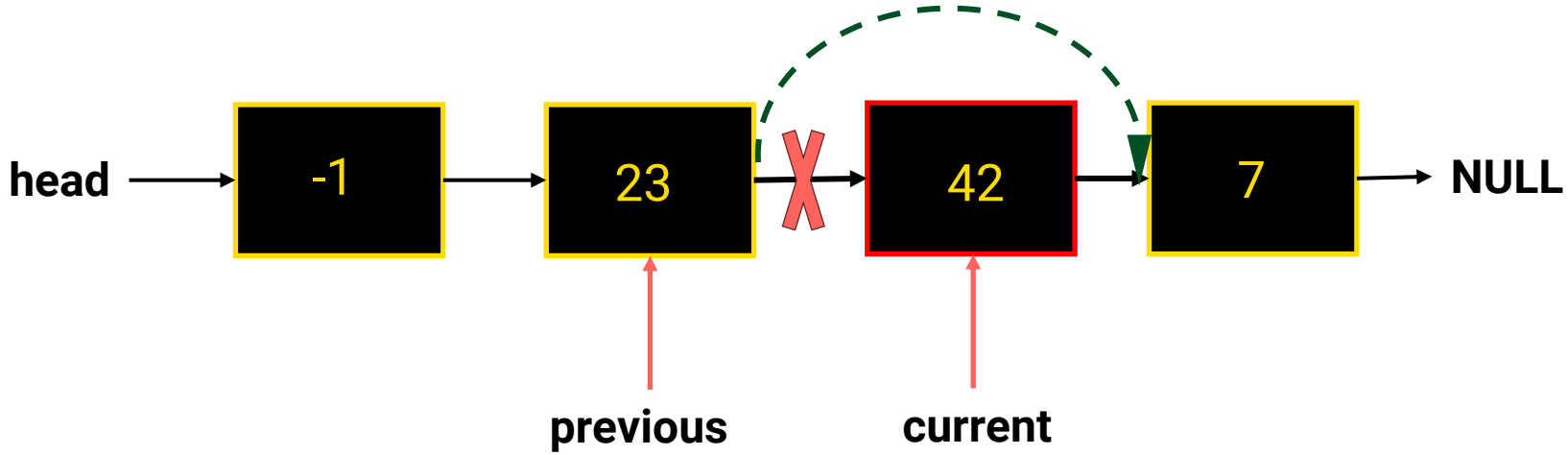


Search and delete between 2 nodes

Method 1

Now, we must **update the links** so that the **previous node points to the node that comes after the one being removed (current).**

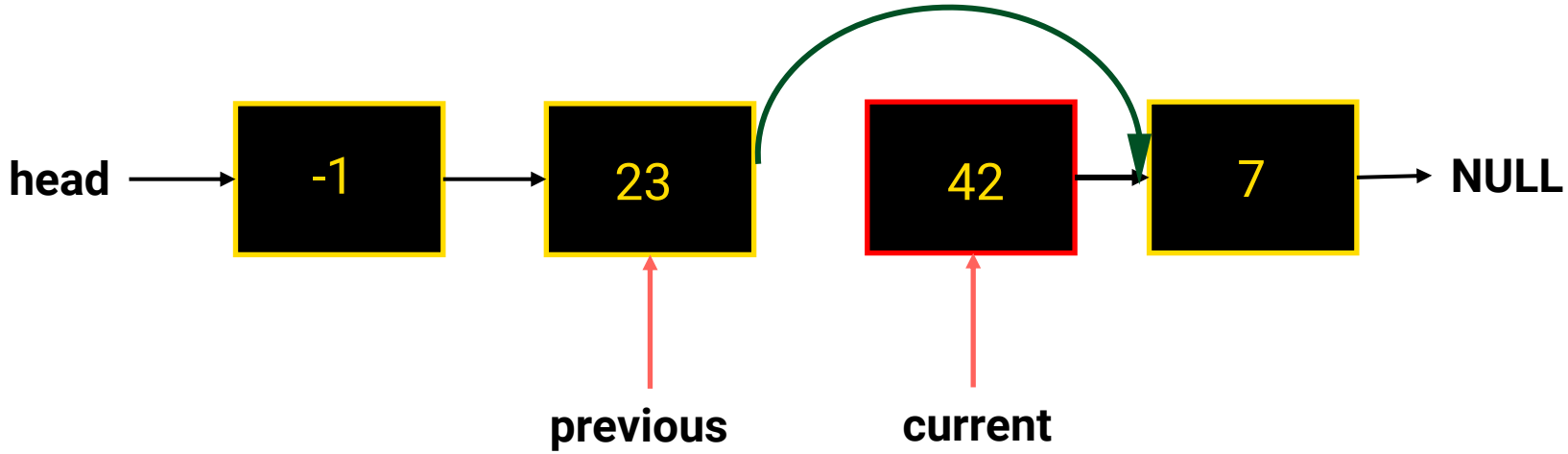


Search and delete between 2 nodes

Method 1

To connect **previous node to the node that comes after the one being removed (current).**

```
previous->next = current->next;
```

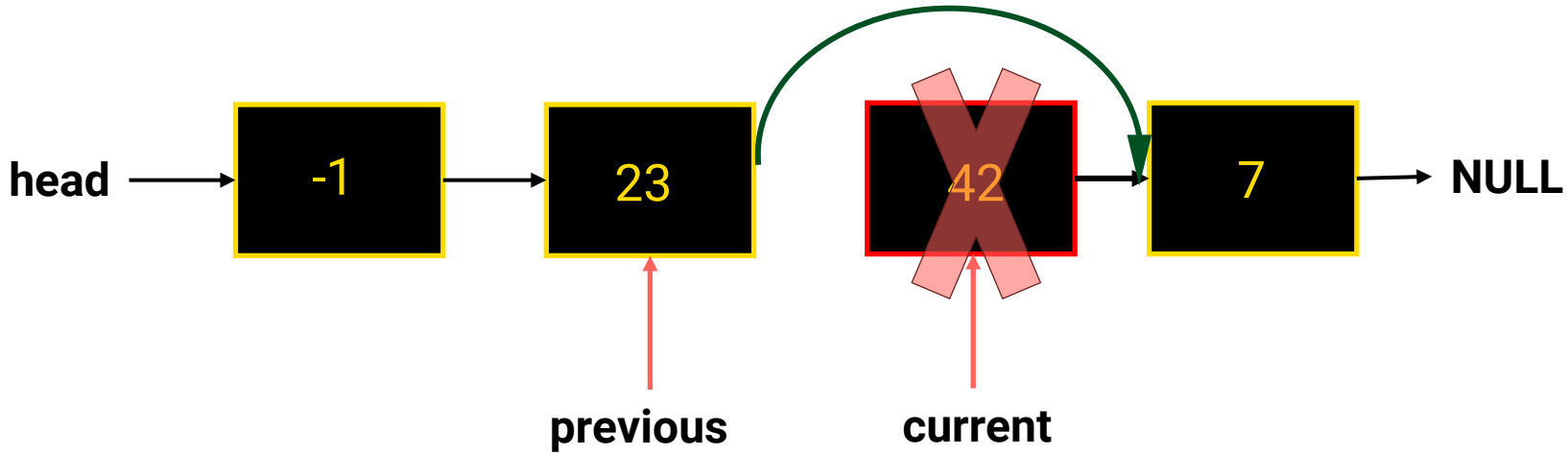


Search and delete between 2 nodes

Method 1

Now we can **free** the node we wanted to **remove (current)**

```
free(current);
```

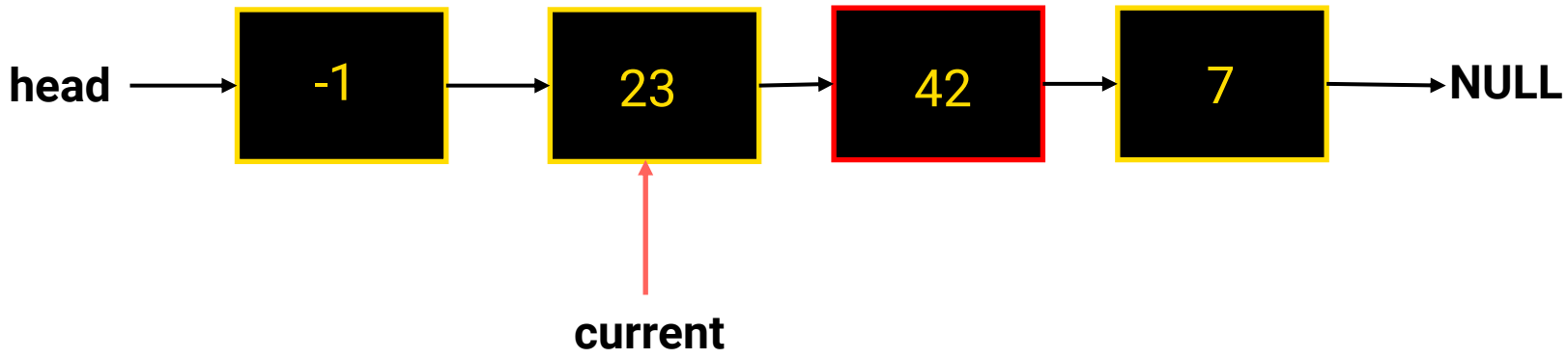


Search and delete between 2 nodes

Method 2

Use only one pointer (current) to move through the list.
Instead of looking at the current node's data,
we examine the NEXT node's data (current->next).

Why? Because if current->next contains the value
we want to delete, then 'current' is the node
right before the one we need to remove.

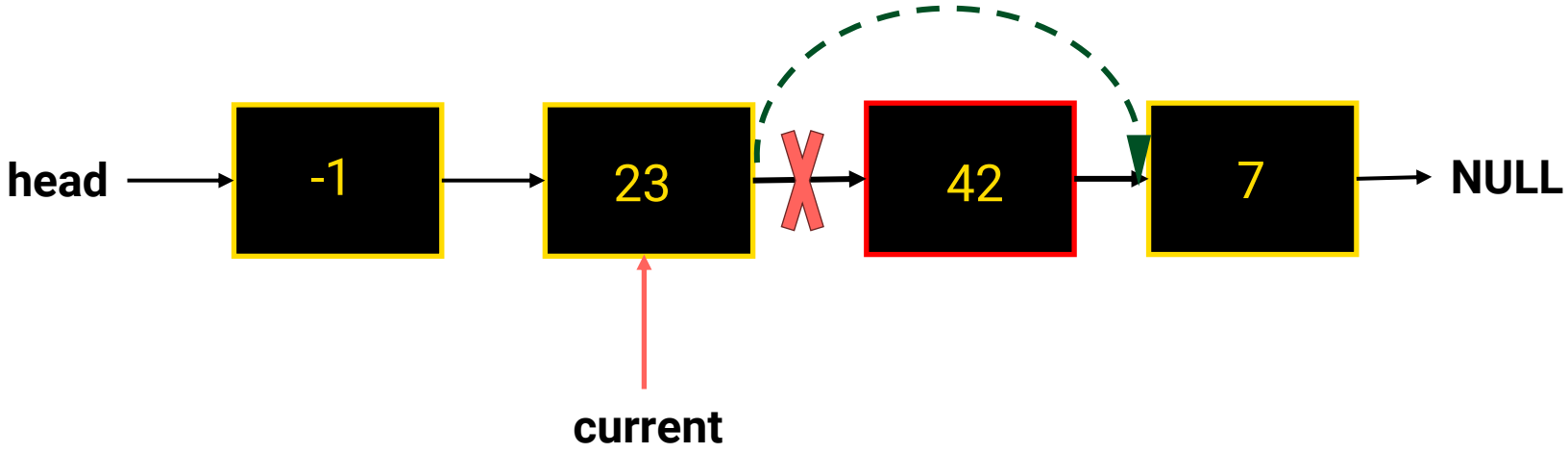


Search and delete between 2 nodes

Method 2

Next, we must update the link **so that the current node points to the node after the one being removed**. However, we still **need a separate pointer** to the node we intend to **free**. **Otherwise, we lose it!!!!!**

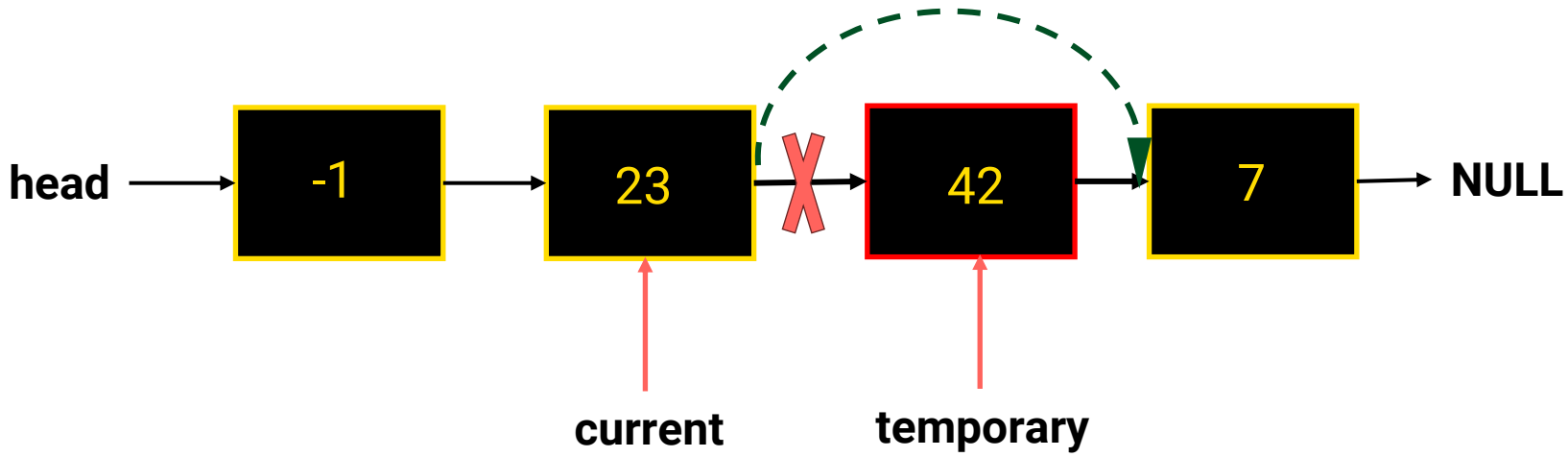
.



Search and delete between 2 nodes

Method 2

```
struct node *temporary = current->next;
```

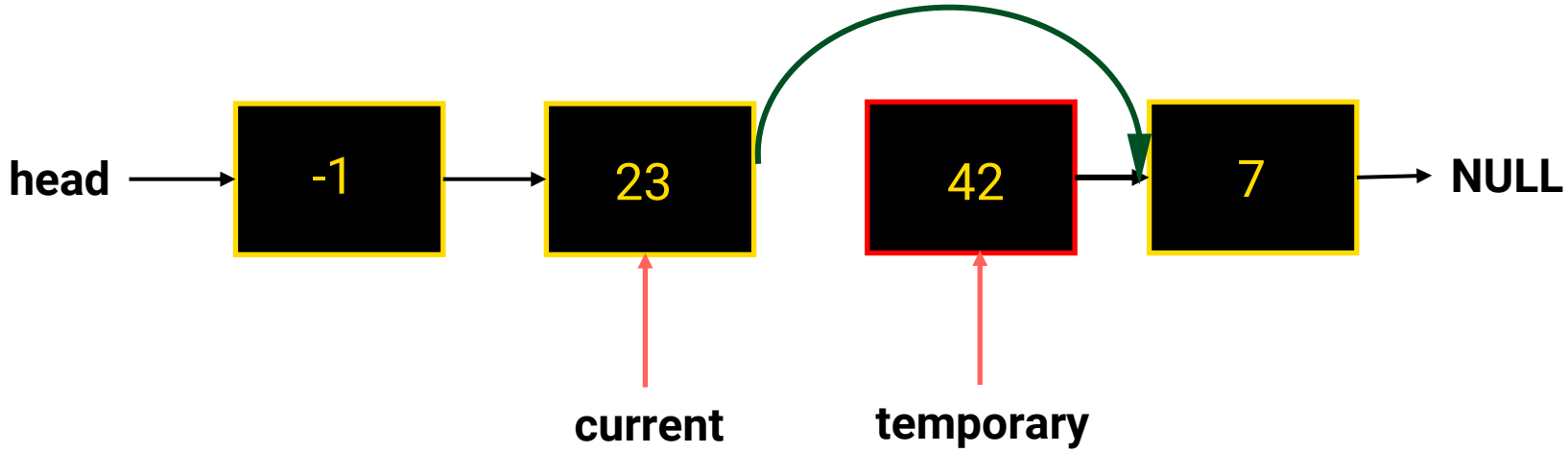


Search and delete between 2 nodes

Method 2

To connect **current node to the node that comes after the one being removed (temporary):**

```
current->next = temporary->next;
```

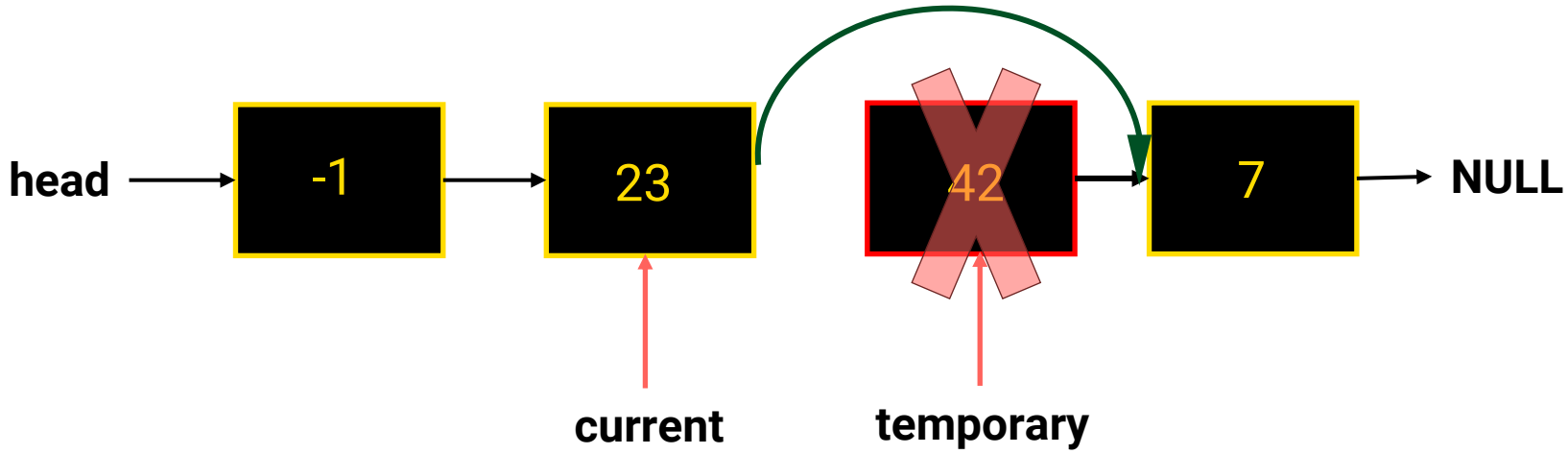


Search and delete between 2 nodes

Method 2

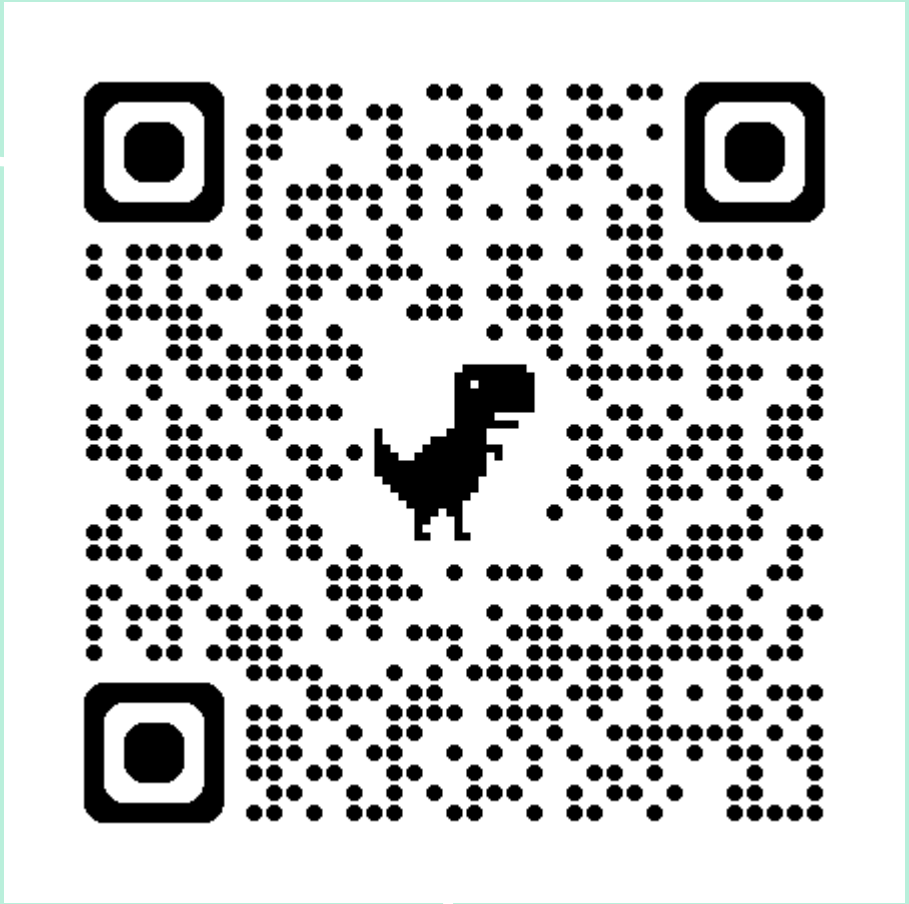
Now we can **free** the node we wanted to **remove (current)**

```
free(temporary);
```



Demo

list_delete.c



Live lecture code is written for teaching, not perfection.
It may include extra comments and may not always follow ideal coding style

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Voice of the Student

Anonymous ongoing feedback
Anything you wanted to share with me

26T1 Voice of the Student – Fill out form

See you soon …

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