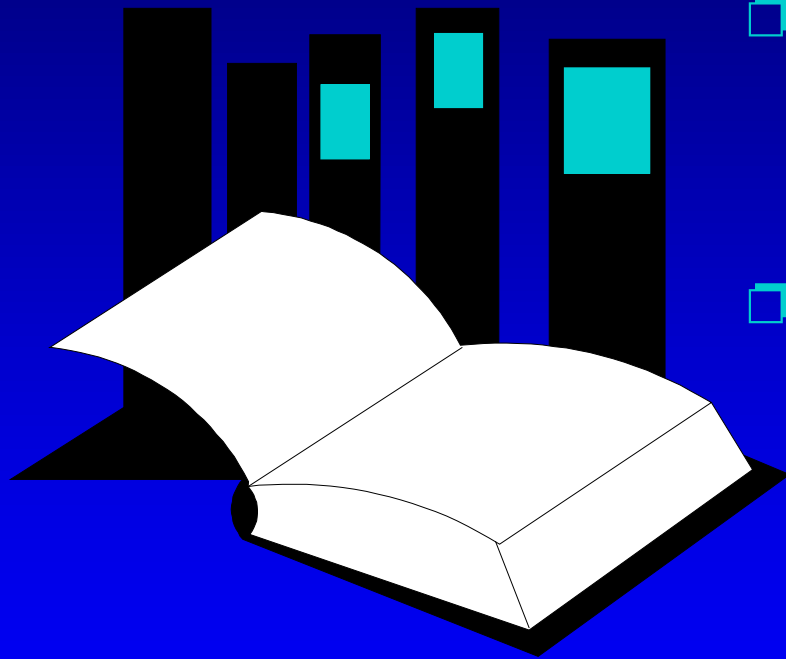
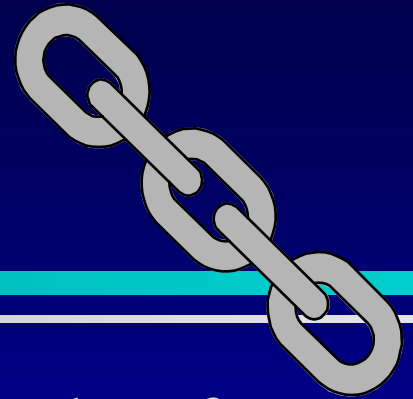


Linked Lists in Action



- ❑ Chapter 5 introduces the often-used data public classure of linked lists.
- ❑ This presentation shows how to implement the most common operations on linked lists.

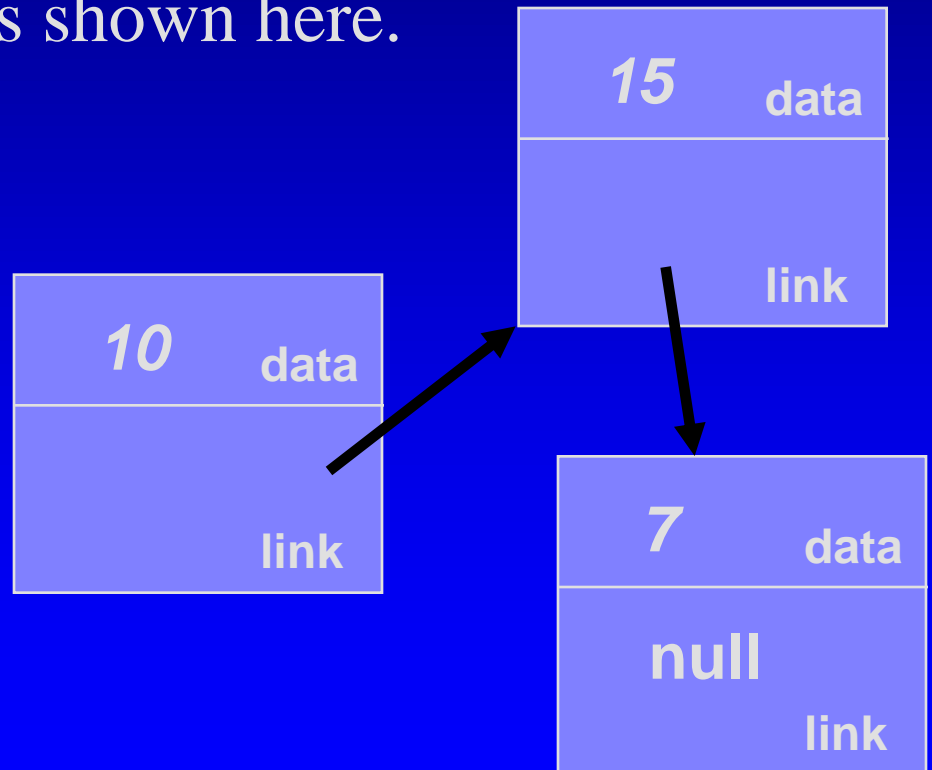
CHAPTER 4

Data public classures and Other Objects

Declarations for Linked Lists

- ❑ For this presentation, each node in the linked list is a class, as shown here.

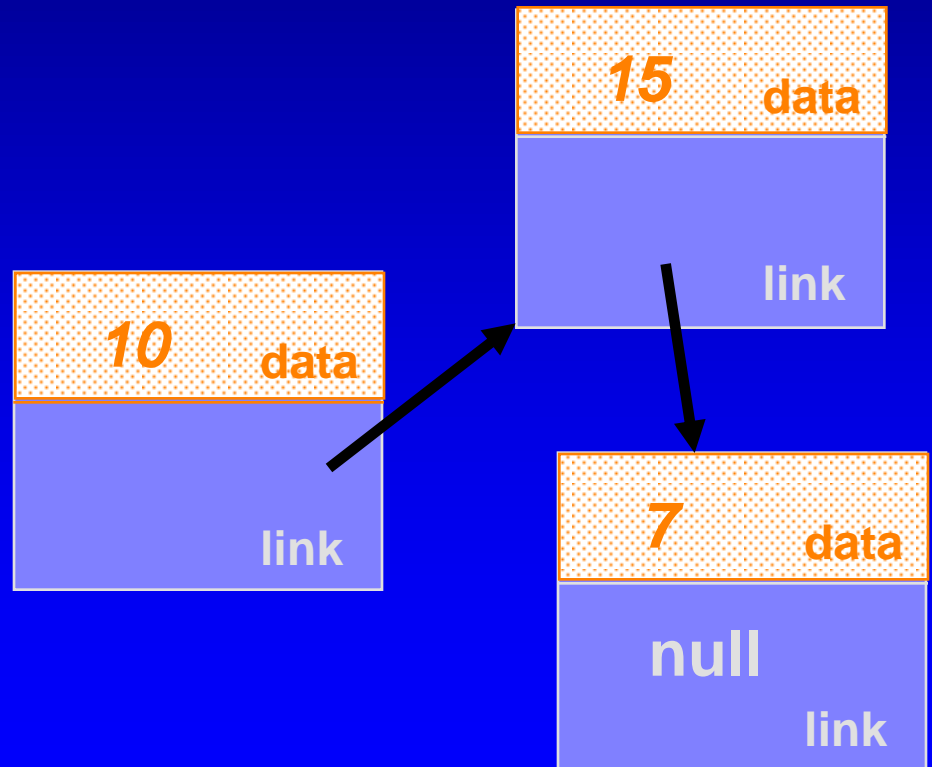
```
public class IntNode
{
    private int data;
    private IntNode link;
    ...
}
```



Declarations for Linked Lists

- ❑ The data portion of each node is an int.

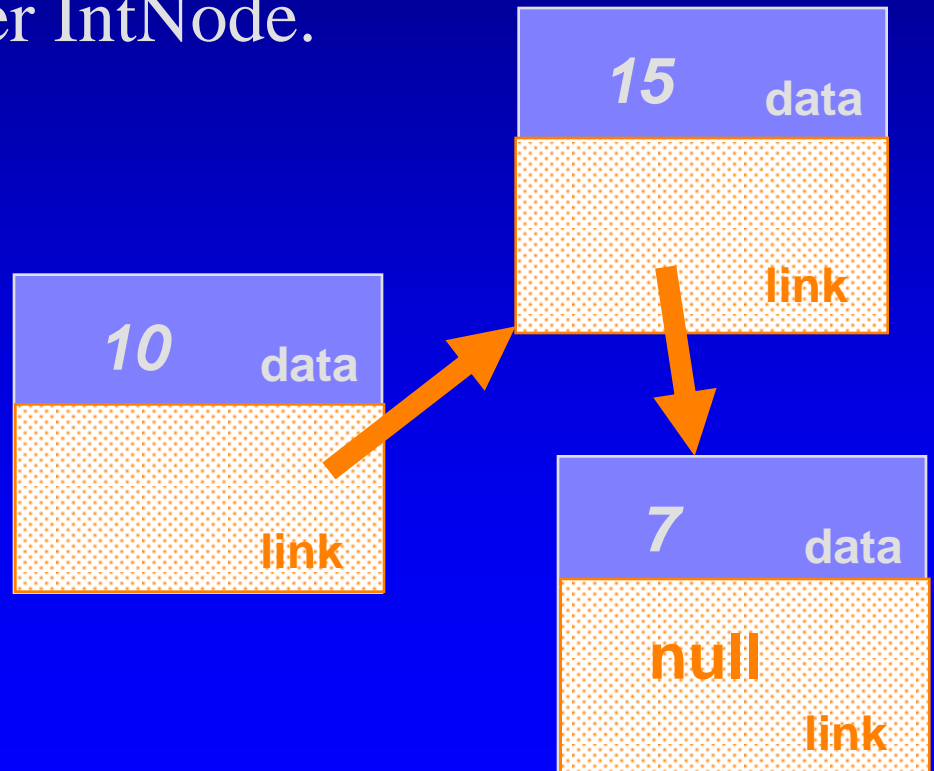
```
public class IntNode
{
    private int data;
    private IntNode link;
    ...
}
```



Declarations for Linked Lists

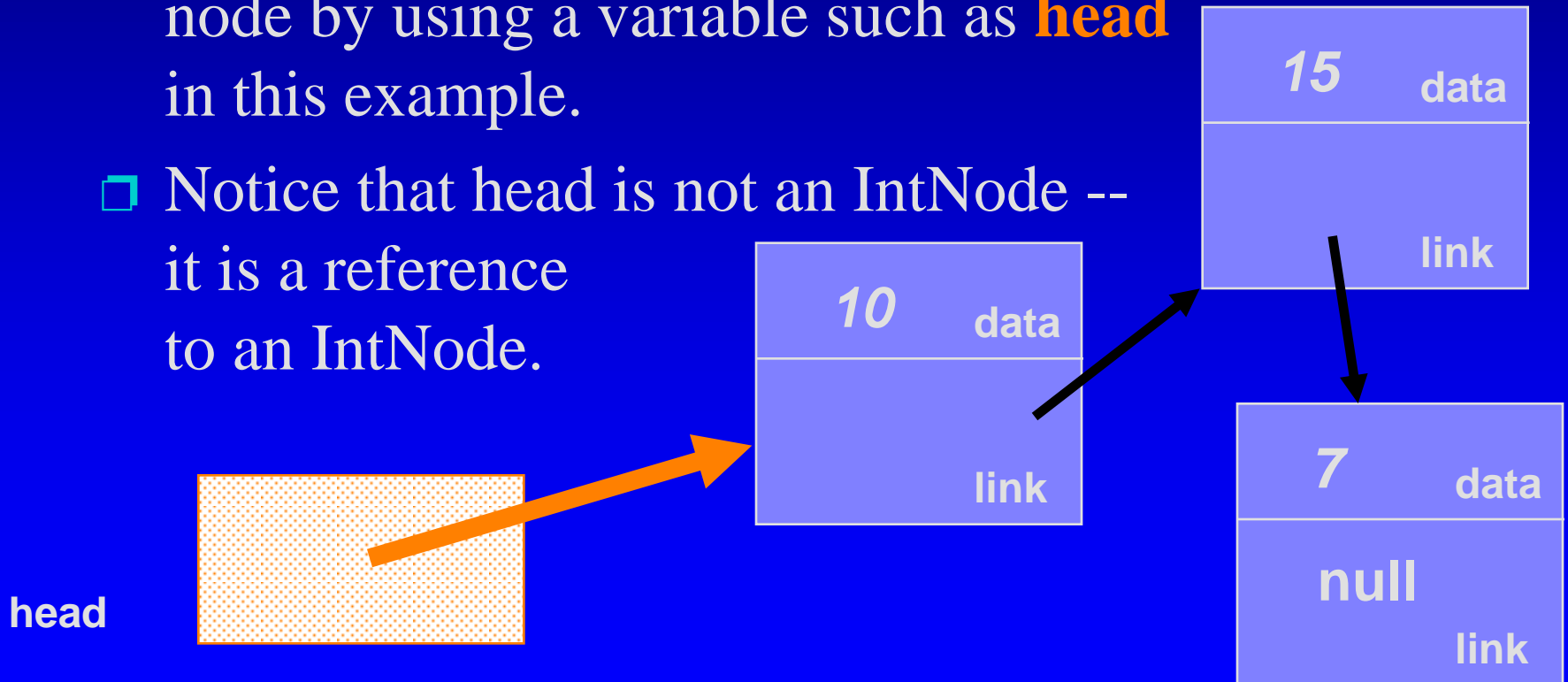
- ❑ Each IntNode also contains a link which refers to another IntNode.

```
public class IntNode
{
    private int data;
    private IntNode link;
    ...
}
```



Declarations for Linked Lists

- ❑ A program can keep track of the front node by using a variable such as **head** in this example.
- ❑ Notice that head is not an IntNode -- it is a reference to an IntNode.



Declarations for Linked Lists

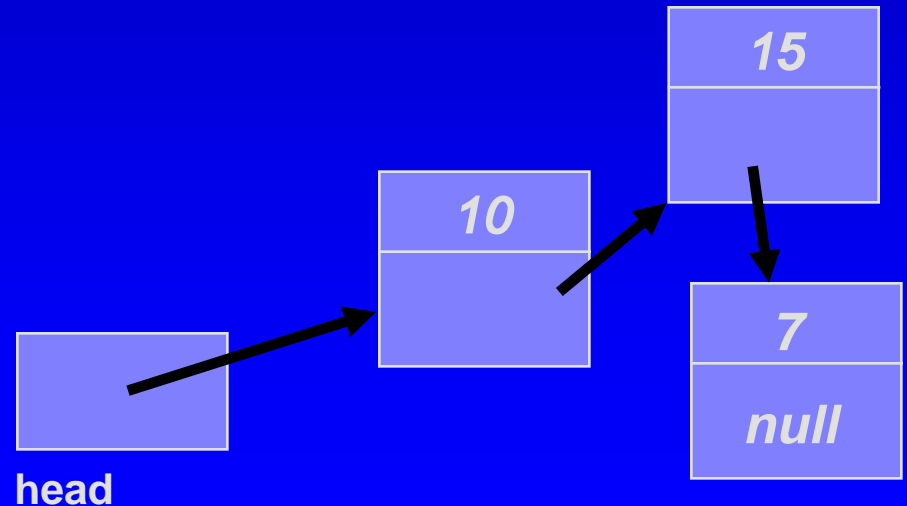
- ❑ A program can keep track of the front node by using an IntNode reference variable such as **head**.
- ❑ Notice that head is not an IntNode -- it is a reference to an IntNode.
- ❑ We represent the empty list by storing **null** in the head reference.

head



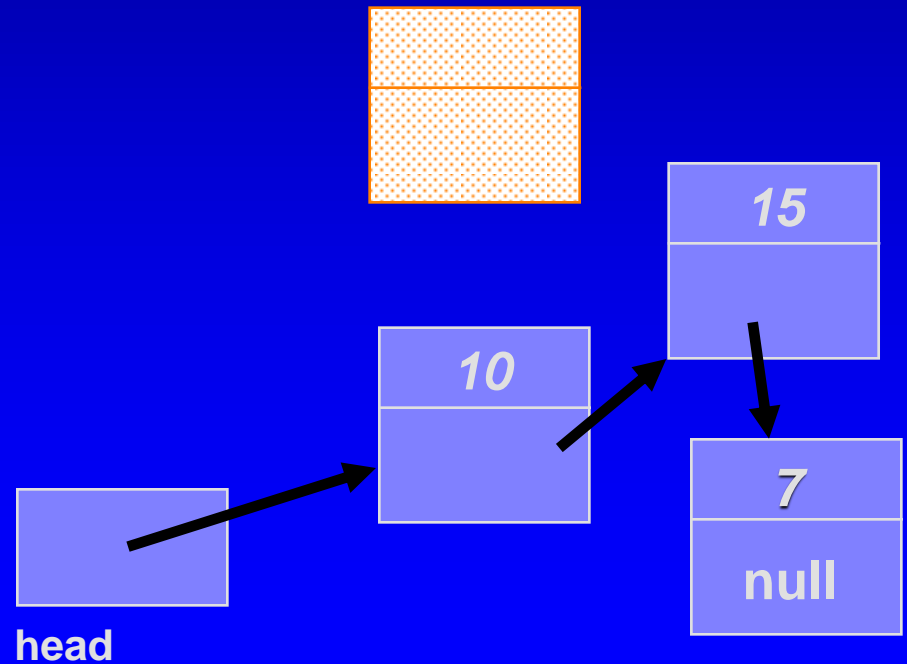
Inserting an IntNode at the Front

We want to add a new entry, 13, to the **front** of the linked list shown here.



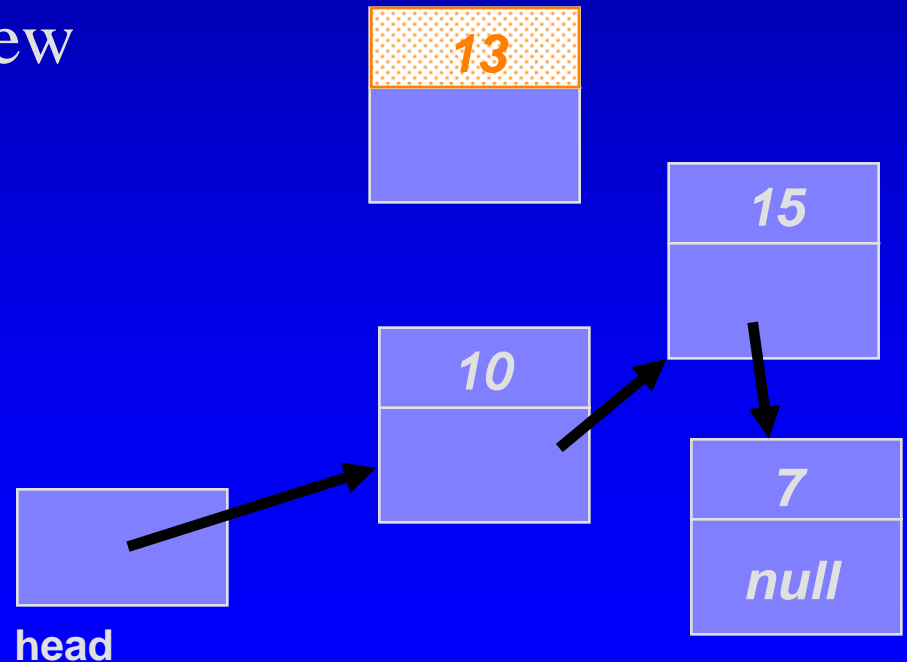
Inserting an IntNode at the Front

① Create a new node...



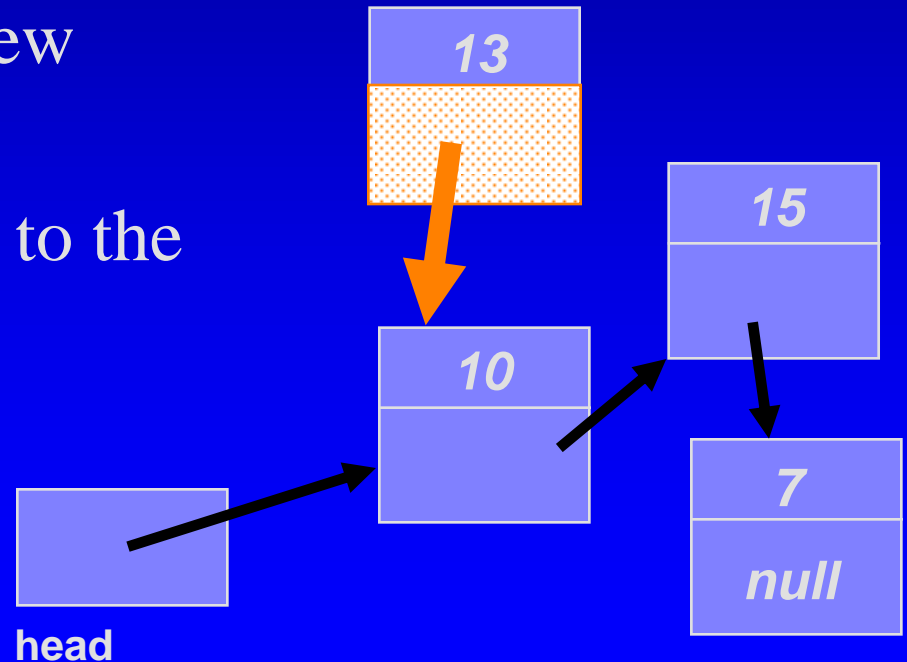
Inserting an IntNode at the Front

- ❶ Create a new node...
- ❷ Place the data in the new node's data field.



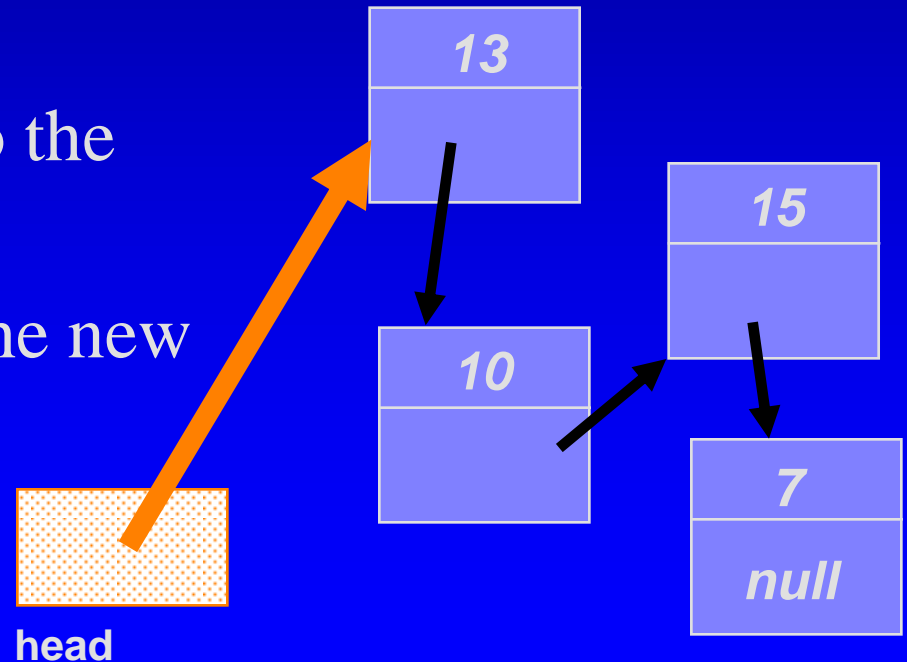
Inserting an IntNode at the Front

- ❶ Create a new node...
- ❷ Place the data in the new node's data field....
- Ž Connect the new node to the front of the list.



Inserting an IntNode at the Front

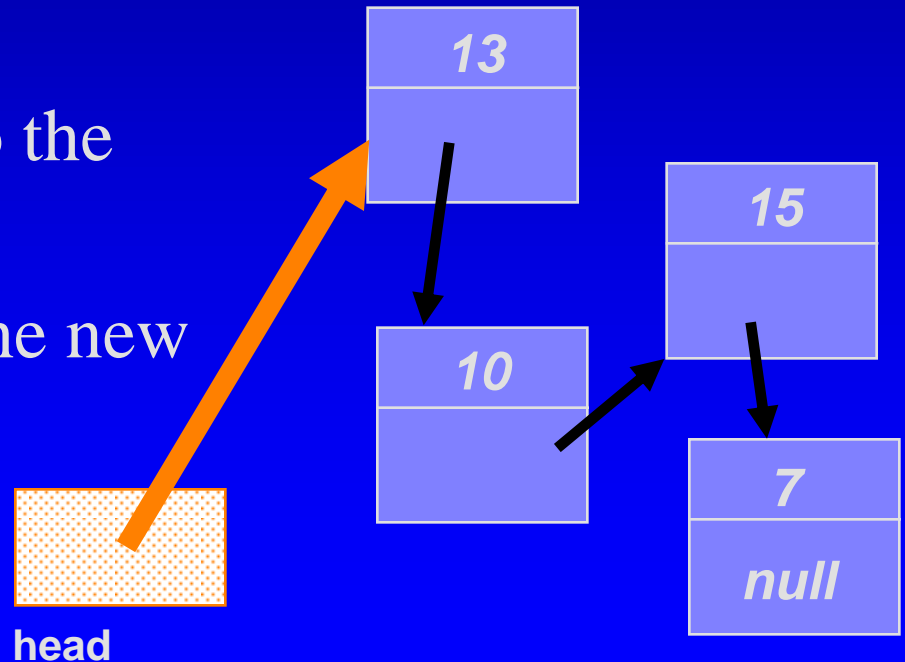
- ❶ Create a new node...
- ❷ Place the data in the new node's data field....
- ❸ Connect the new node to the front of the list.
- ❹ Make the head refer to the new head of the linked list.



Inserting an IntNode at the Front

```
head = new IntNode(13, head);
```

- ❶ Create a new node...
- ❷ Place the data in the new node's data field....
- ❸ Connect the new node to the front of the list.
- ❹ Make the head refer to the new head of the linked list.



Inserting an IntNode at the Front

```
public IntNode(int initialData, IntNode initialLink)
{
    data = initialEntry;
    link = initialLink;
}
```

Inserting an IntNode at the Front

```
public IntNode(int initialData, IntNode initialLink)
{
    data = initialEntry;
    link = initialLink;
}
```

*Does the constructor work
correctly for the first
node on a new list ?*

Inserting an IntNode at the Front

```
public IntNode(int initialData, IntNode initialLink)
{
    data = initialEntry;
    link = initialLink;
}
```

*Suppose head is null
and we execute the
assignment shown here:*

```
head = new IntNode(13, head);
```

null

head

Inserting an IntNode at the Front

```
public IntNode(int initialData, IntNode initialLink)
{
    data = initialEntry;
    link = initialLink;
}
```

```
head = new IntNode(13, head);
```

null

head

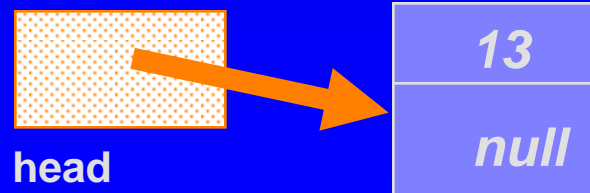
13

null

Inserting an IntNode at the Front

```
public IntNode(int initialData, IntNode initialLink)
{
    data = initialEntry;
    link = initialLink;
}
```

```
head = new IntNode(13, head);
```

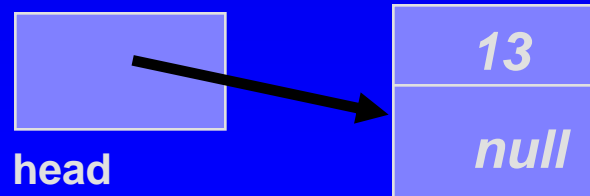


Inserting an IntNode at the Front

```
public IntNode(int initialData, IntNode initialLink)
{
    data = initialEntry;
    link = initialLink;
}
```

When the statement
finishes, the linked list
has one node,
containing 13.

```
head = new IntNode(13, head);
```



Caution!

- ❑ Always make sure that your linked list methods work correctly with an empty list.



Pseudocode for Inserting IntNodes

- ❑ IntNodes are often inserted at places other than the front of a linked list.
- ❑ There is a general pseudocode that you can follow for any insertion function. . .

Pseudocode for Inserting IntNodes

- ① Determine whether the new node will be the first node in the linked list. If so, then there is only one step:

```
head = new IntNode(newEntry, head);
```

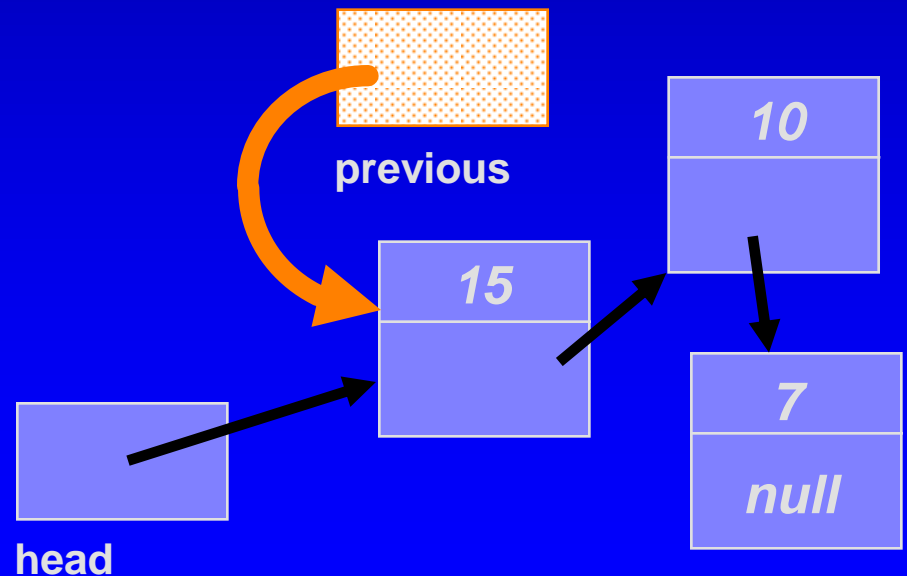
Pseudocode for Inserting IntNodes

- ② Otherwise (if the new node will not be first):
 - ❑ Start by setting a reference named **previous** to refer to the node which is just **before** the new node's position.

Pseudocode for Inserting IntNodes

- ② Otherwise (if the new node will not be first):
 - ❑ Start by setting a reference named **previous** to refer to the node which is just **before** the new node's position.

In this example, the new node will be the second node

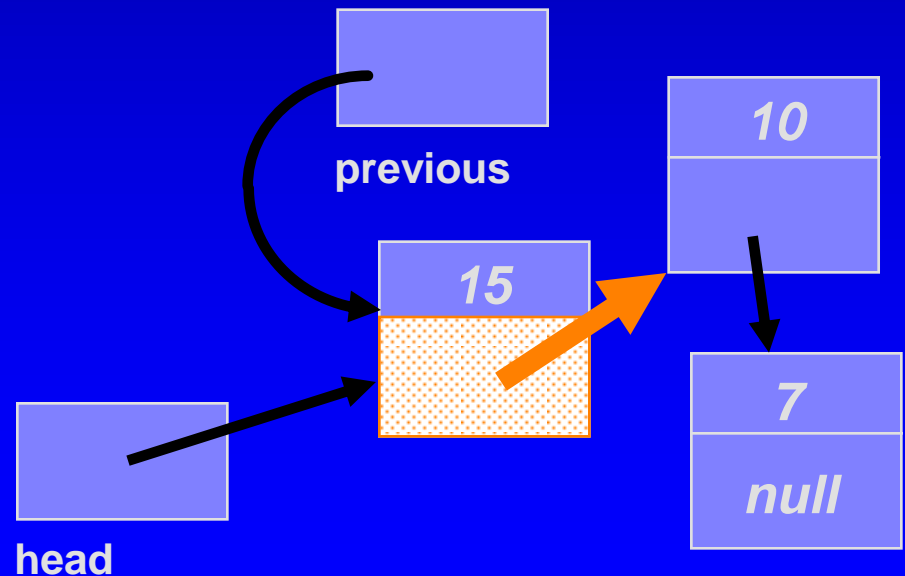


Pseudocode for Inserting IntNodes

- ② Otherwise (if the new node will not be first):
 - ❑ Start by setting a reference named `previous` to refer to the node which is just before the new node's position

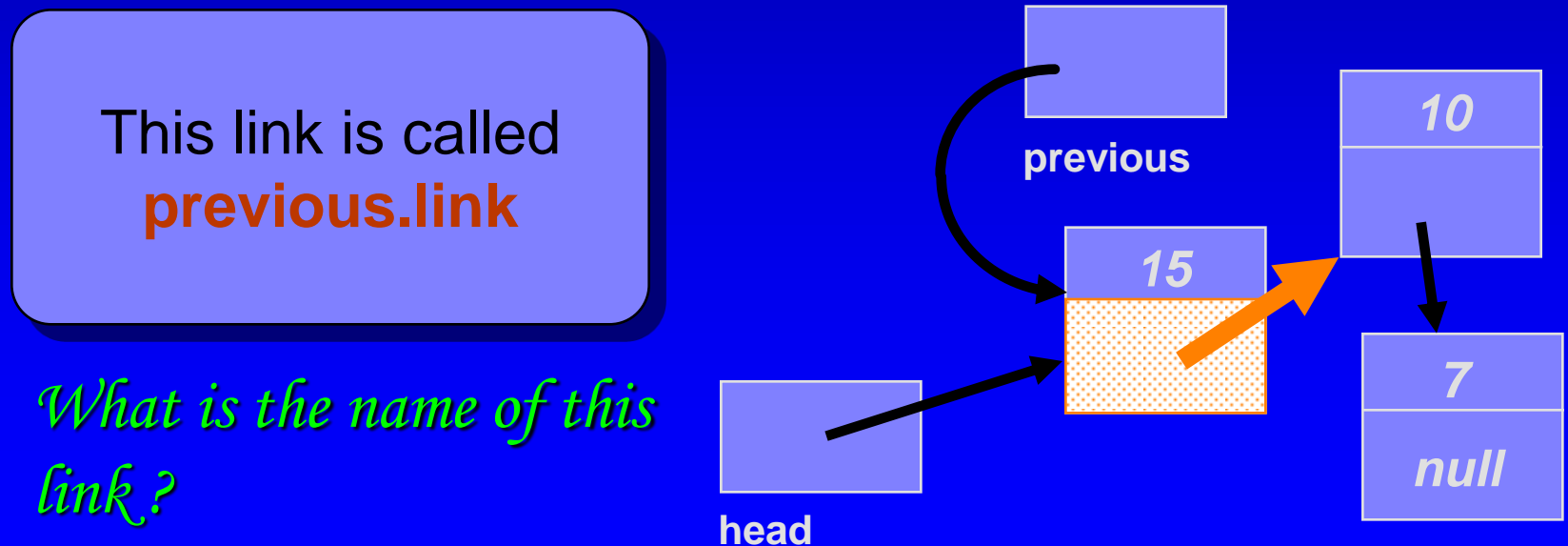
Look at the link which is in the node `previous`

What is the name of this link?



Pseudocode for Inserting IntNodes

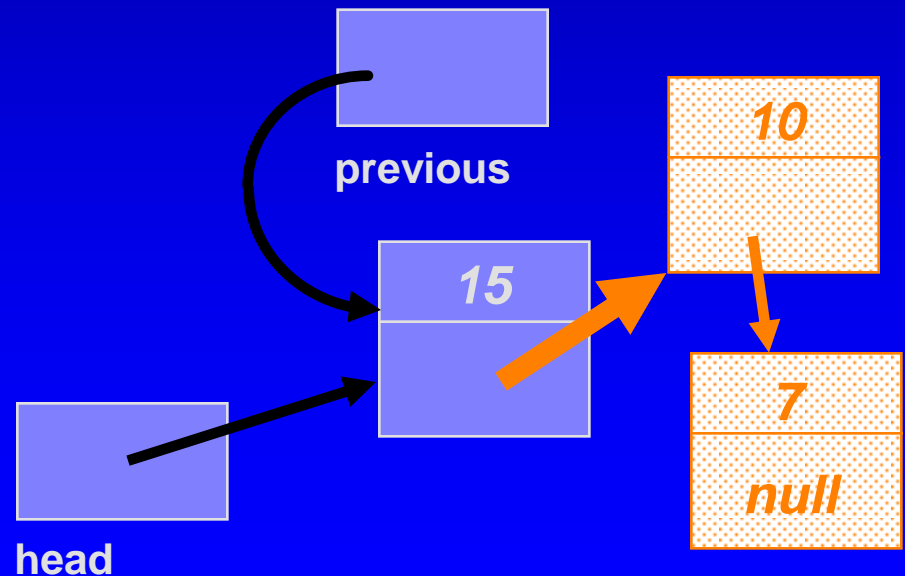
- ② Otherwise (if the new node will not be first):
 - ❑ Start by setting a reference named `previous` to refer to the node which is just before the new node's position



Pseudocode for Inserting IntNodes

- ② Otherwise (if the new node will not be first):
 - ❑ Start by setting a reference named `previous` to refer to the node which is just before the new node's position

previous.link
refers to the head
of a small linked
list, with 10 and 7

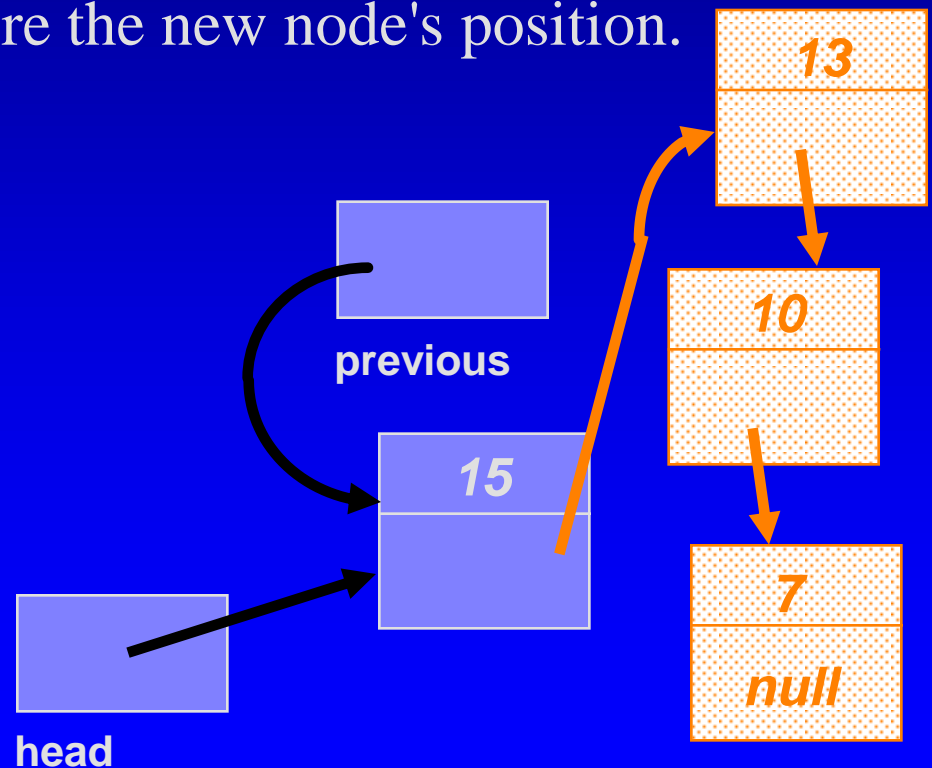


Pseudocode for Inserting IntNodes

- ② Otherwise (if the new node will not be first):
- ❑ Start by setting a reference named `previous` to refer to the node which is just before the new node's position.

The new node must be inserted at the front of this small linked list.

Write one Java statement which will do the insertion.



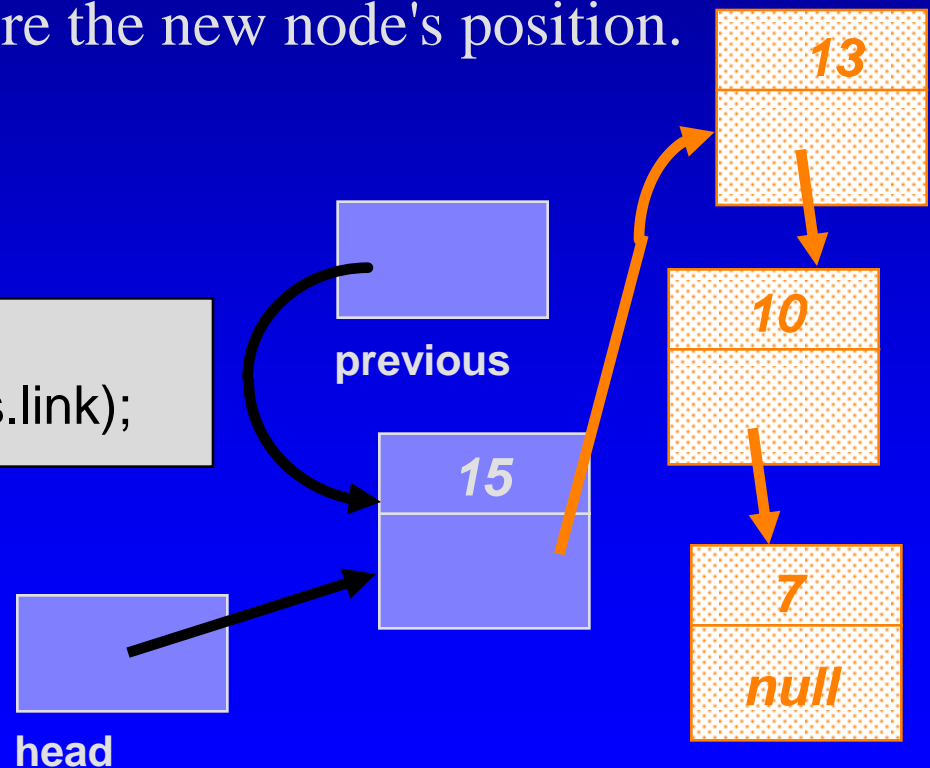
Pseudocode for Inserting IntNodes

② Otherwise (if the new node will not be first):

- ❑ Start by setting a reference named `previous` to refer to the node which is just before the new node's position.

```
previous.link =  
new IntNode(newEntry, previous.link);
```

*Write one Java statement
which will do the insertion.*



Pseudocode for Inserting IntNodes

- ① Determine whether the new node will be the first node in the linked list. If so, then there is only one step:

```
head = new IntNode(newEntry, head);
```

- ② Otherwise (if the new node will not be first):

- ❑ Set a reference named previous to refer to the node which is just before the new node's position.
- ❑ Execute the step:

```
previous.link =  
    new IntNode(newEntry, previous.link);
```

Pseudocode for Inserting IntNodes

- ❑ The process of adding a new node in the middle of a list can also be incorporated as a separate method. This function is called `addNodeAfter` in the linked list toolkit of Section 4.2.

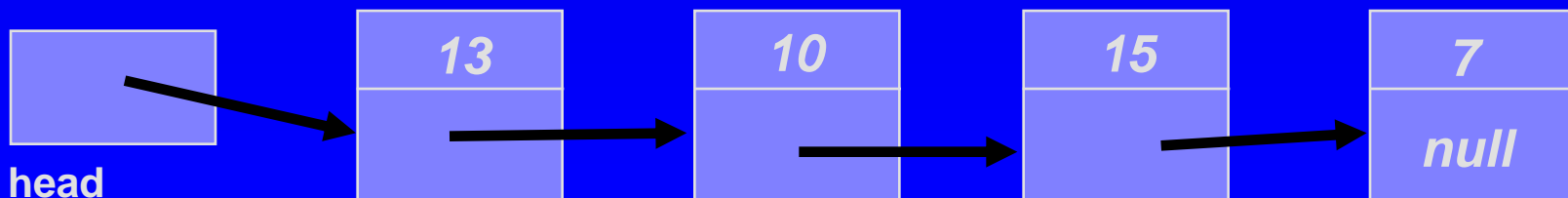
Pseudocode for Removing IntNodes

- ❑ IntNodes often need to be removed from a linked list.
- ❑ As with insertion, there is a technique for removing a node from the front of a list, and a technique for removing a node from elsewhere.
- ❑ We'll look at the technique for removing a node from the front of a linked list.

Removing the Head IntNode

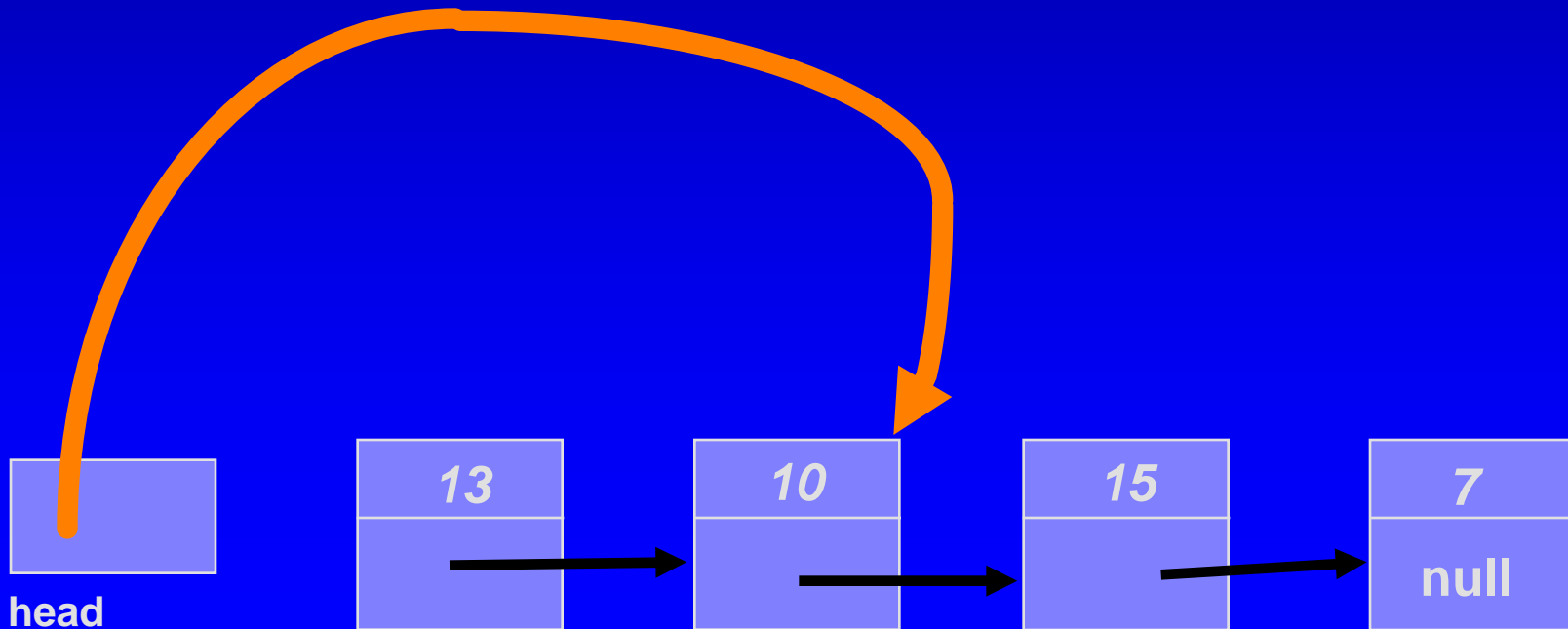
```
head = head.link;
```

Draw the change that this statement will make to the linked list.



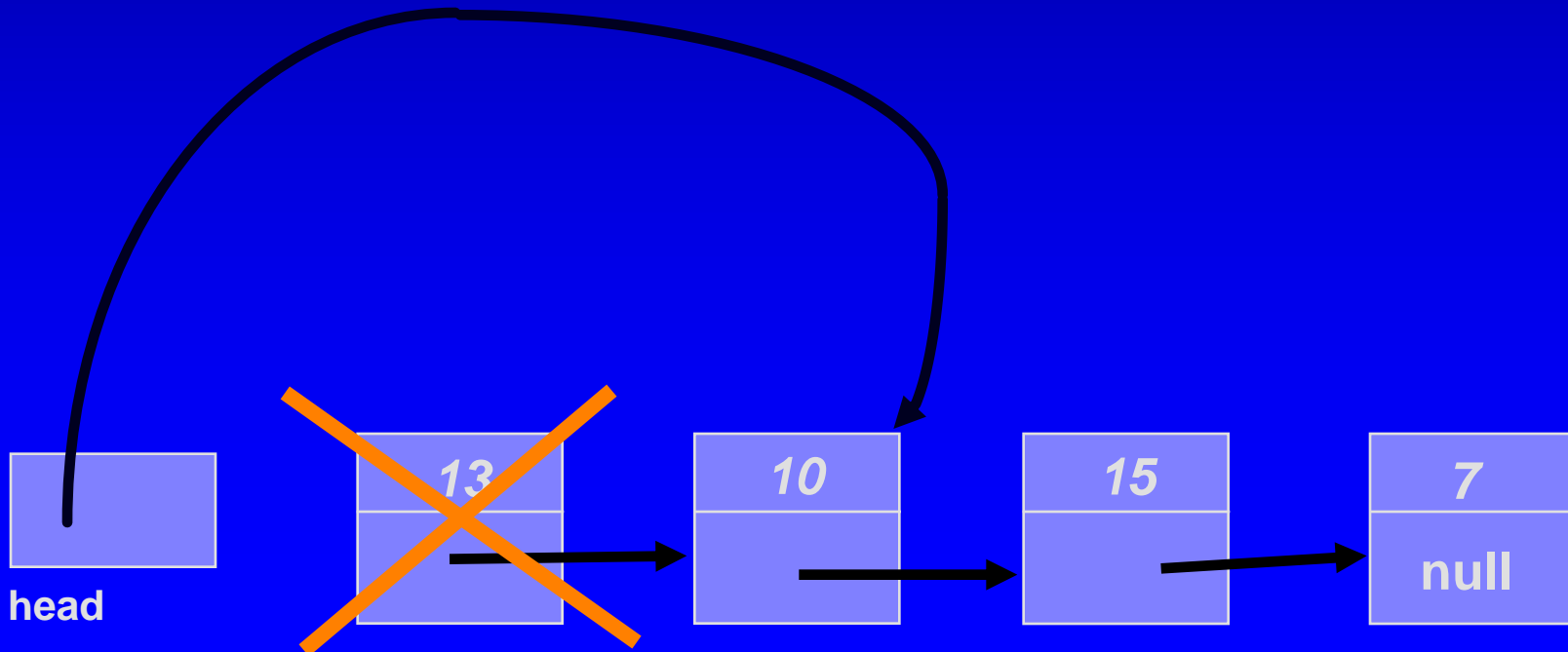
Removing the Head IntNode

```
head = head.link;
```



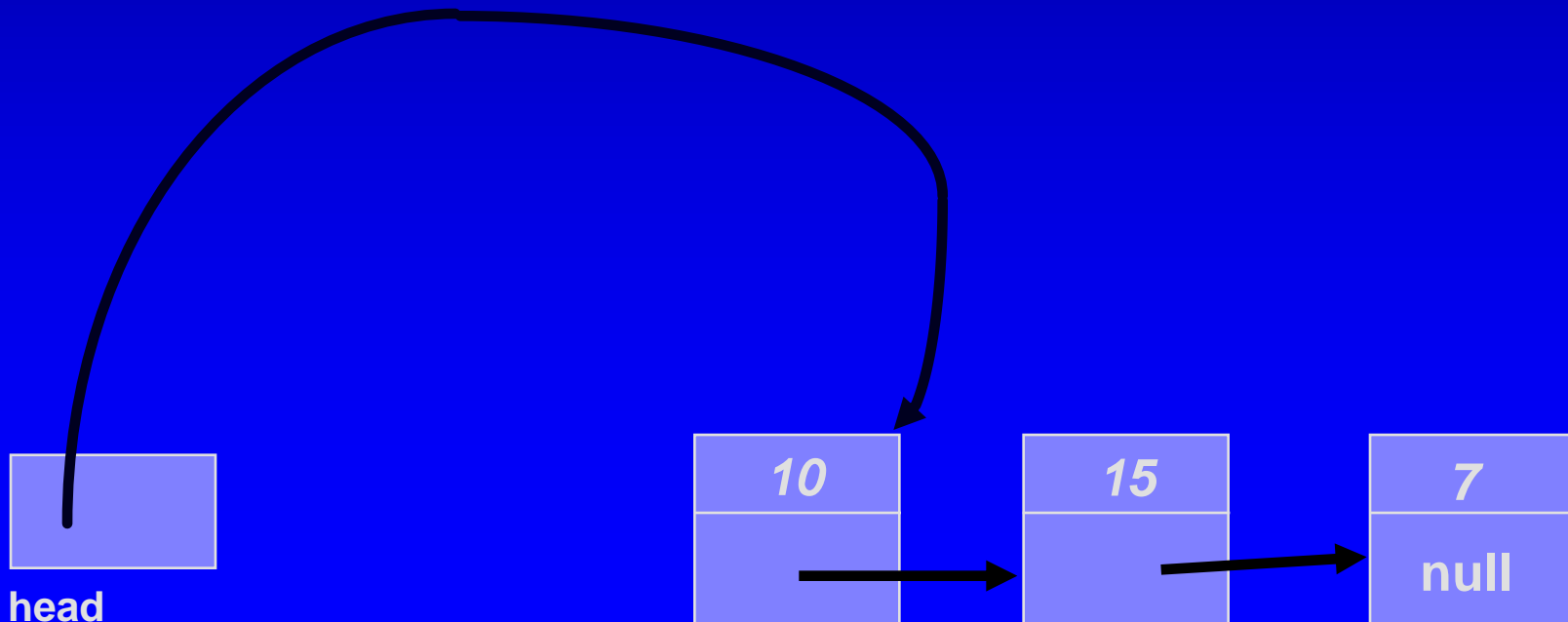
Removing the Head IntNode

```
head = head.link;
```



Removing the Head IntNode

Here's what the linked list looks like after the removal finishes.





Summary

- ❑ It is easy to insert or remove a node at the front of a list.
- ❑ You also need a technique for inserting or removing a node elsewhere

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