Linked Lists

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- Nodes are created/destroyed as necessary. When adding a new element, a new node is created, and linked into the linked list. When removing an element, the node containing the element is destroyed.

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- Linked lists are better for manipulating data, while array lists are better for storing/accessing data.

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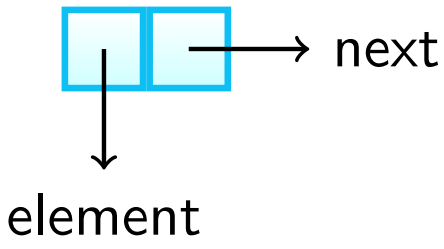
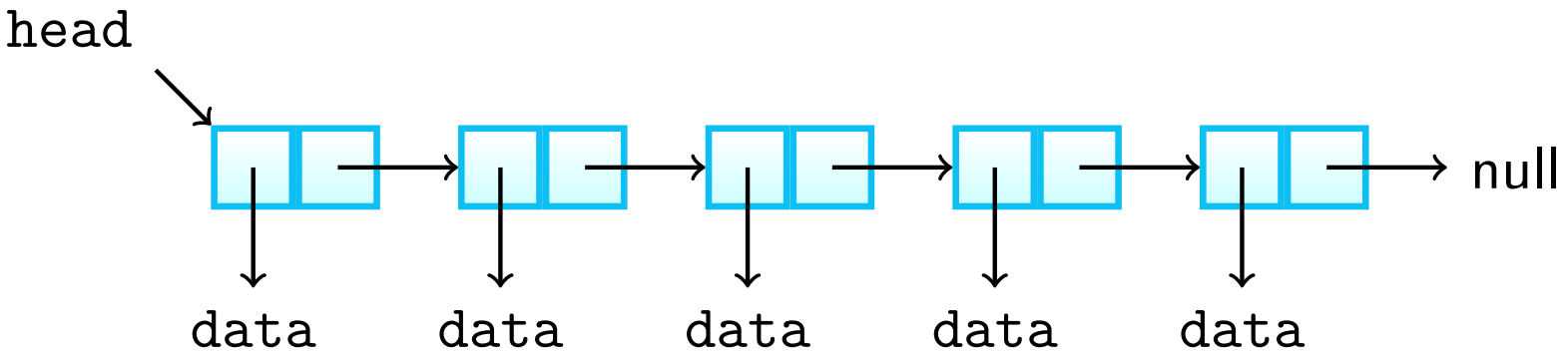


Singly Linked List

In this course, we refrain from creating "dummy" nodes that lead to null references at the end of a singly linked list. We just have the next reference of the last node point to null.

Example of a singly linked list:



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- Update the head reference to point to new node.

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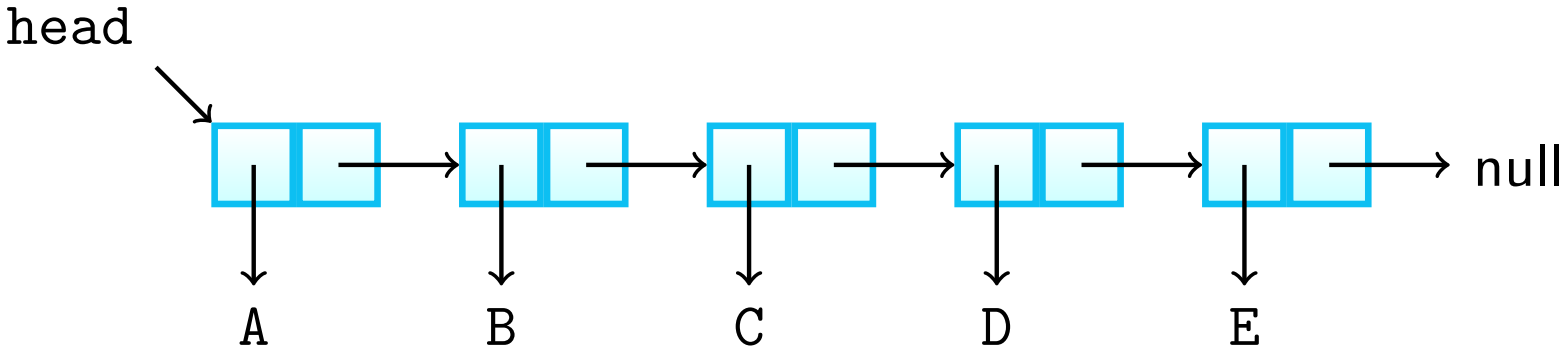

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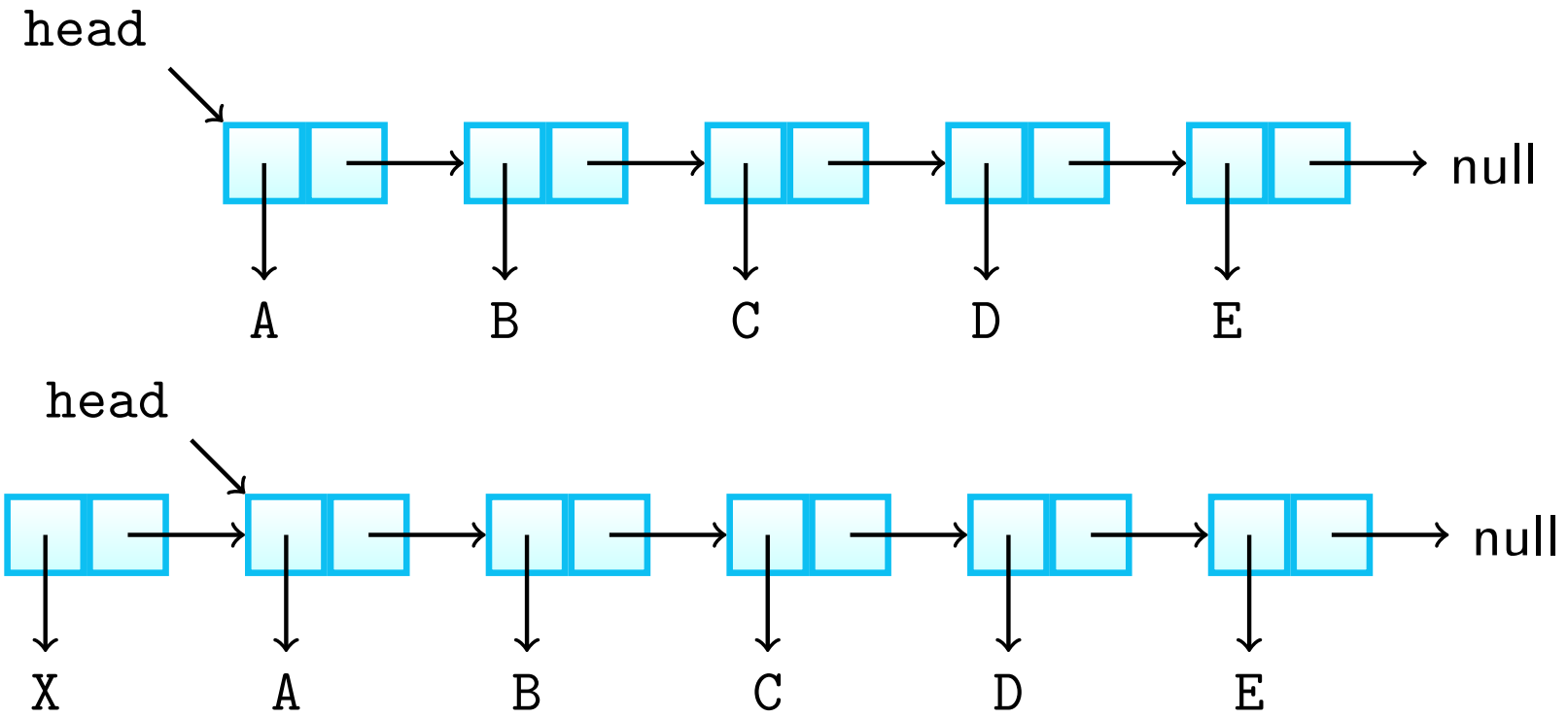

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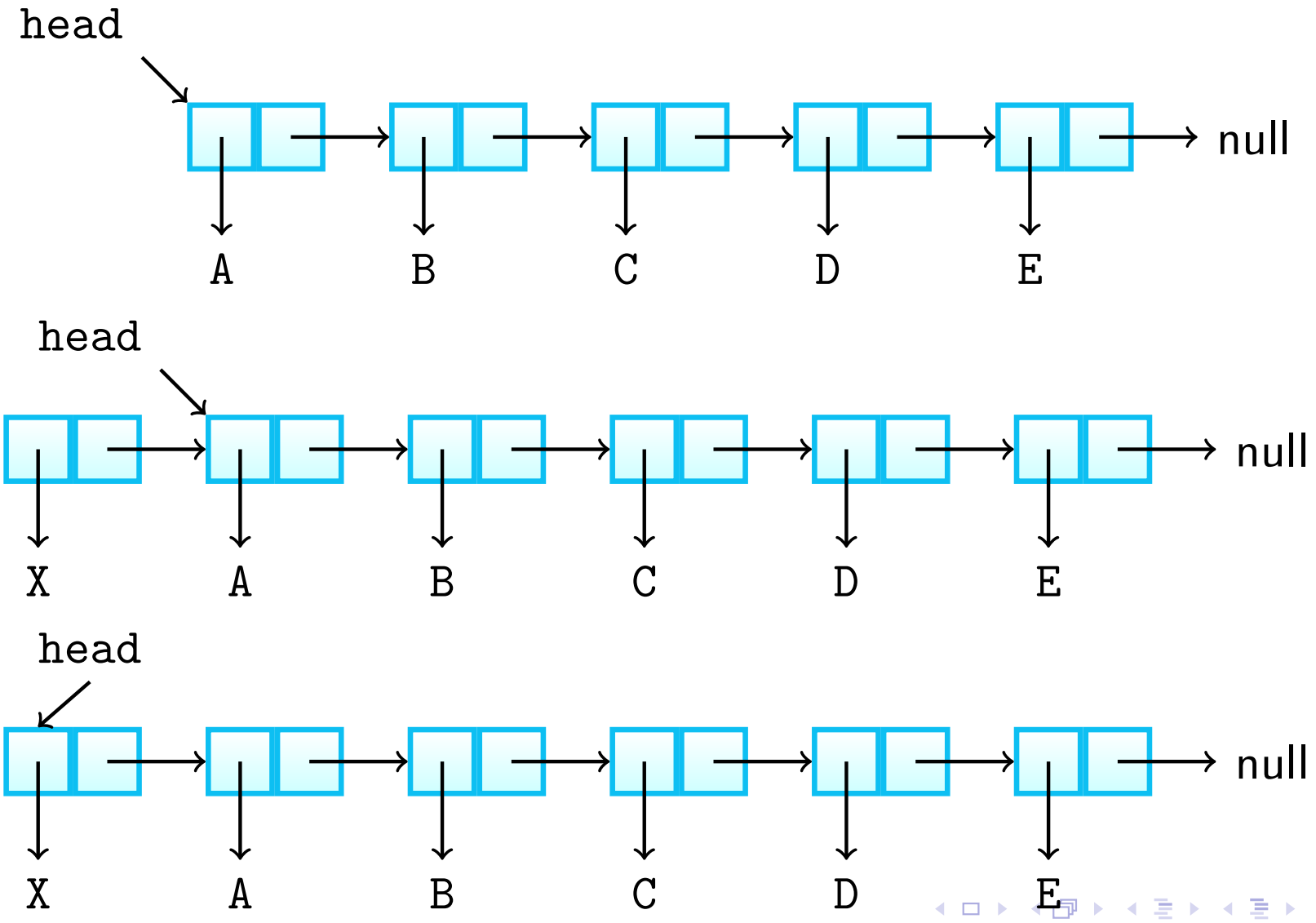

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- Update tail (if there is a tail pointer) to point to new node.

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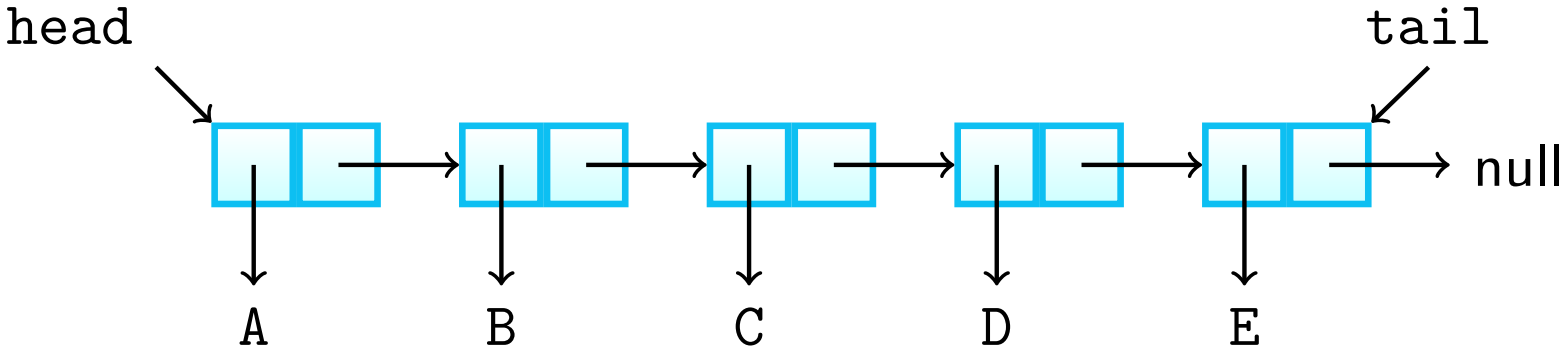

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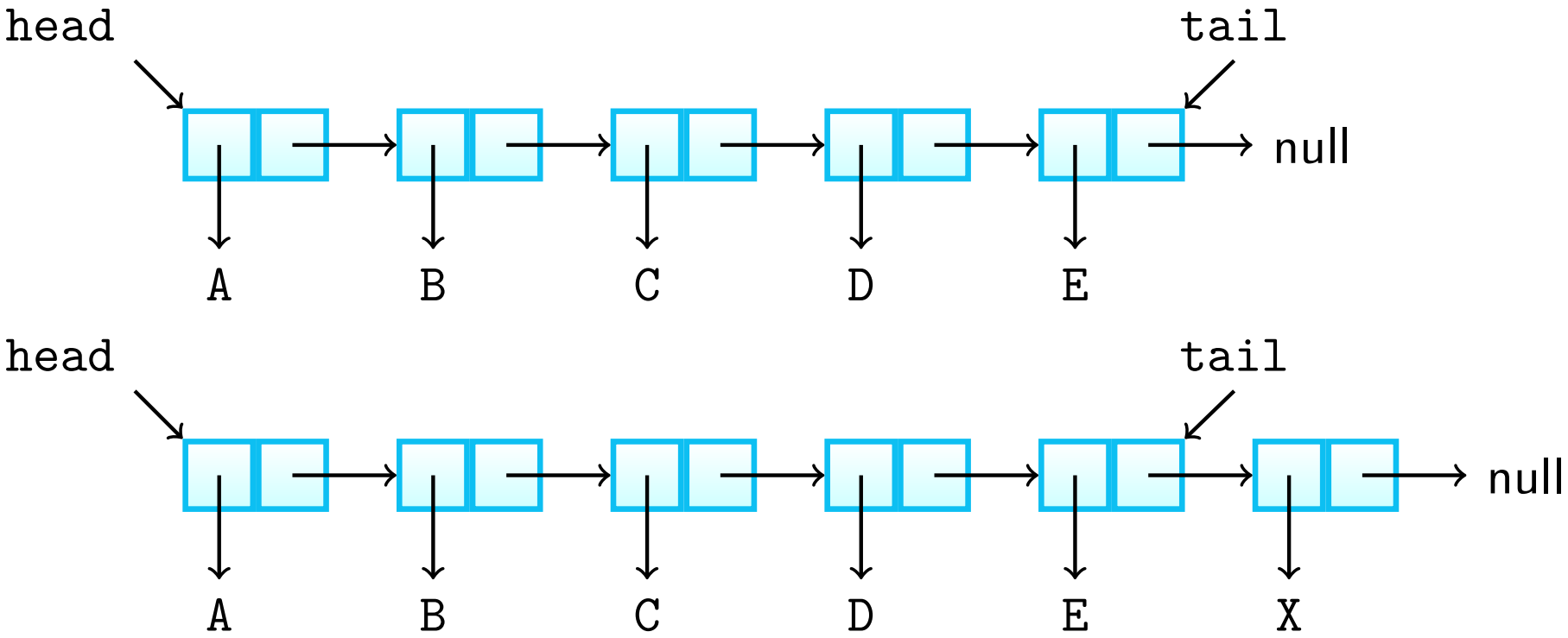

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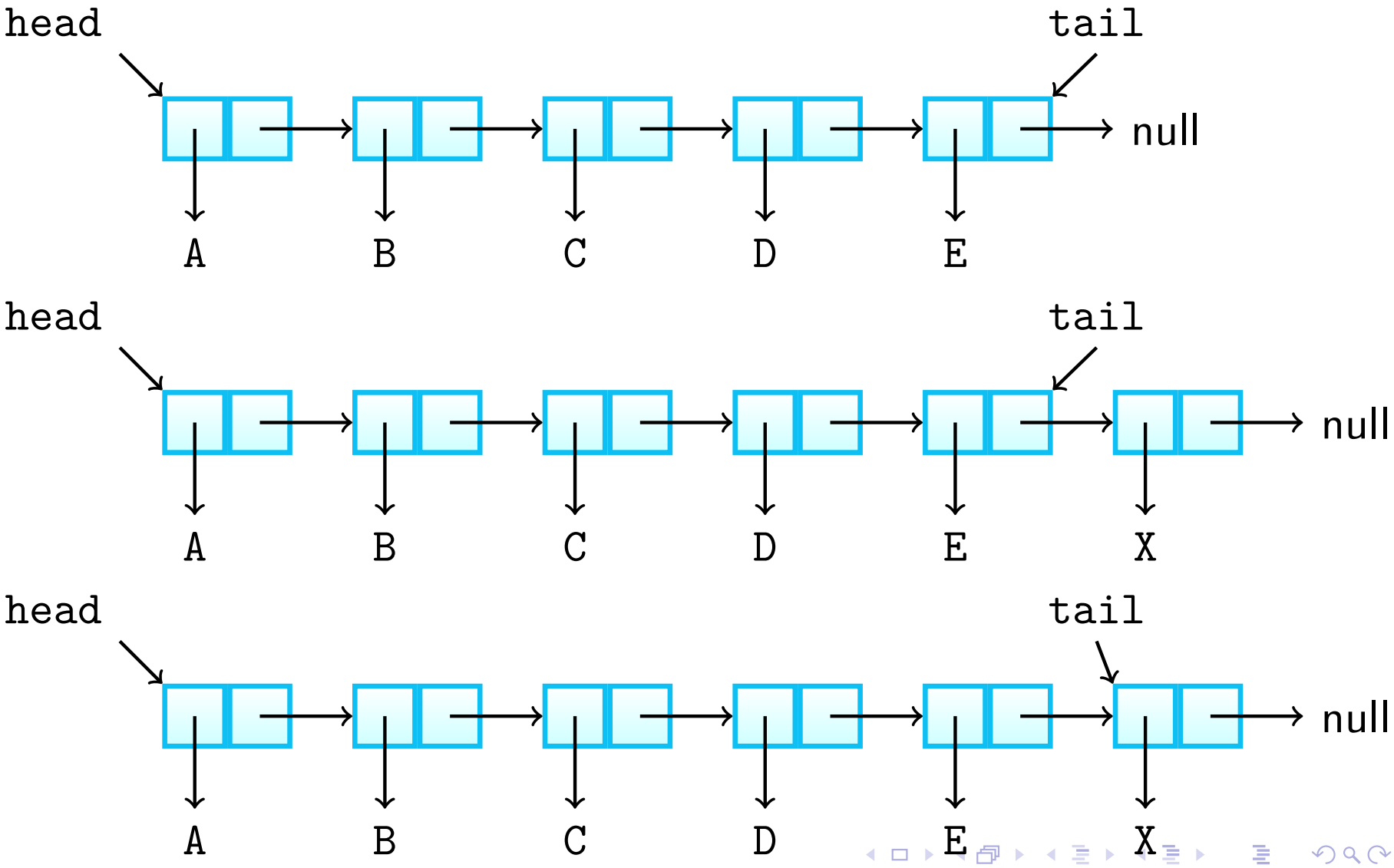

Removing at the Head

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- Allow garbage collector to reclaim the former first node.

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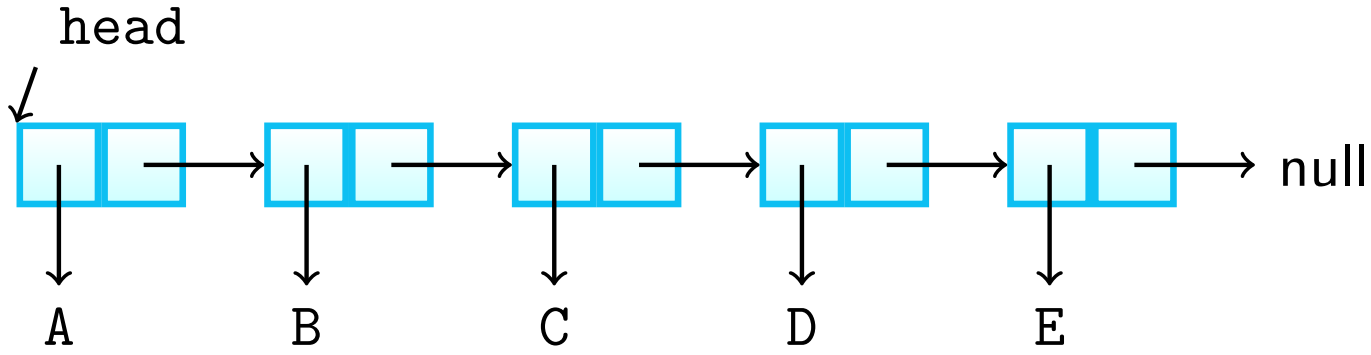

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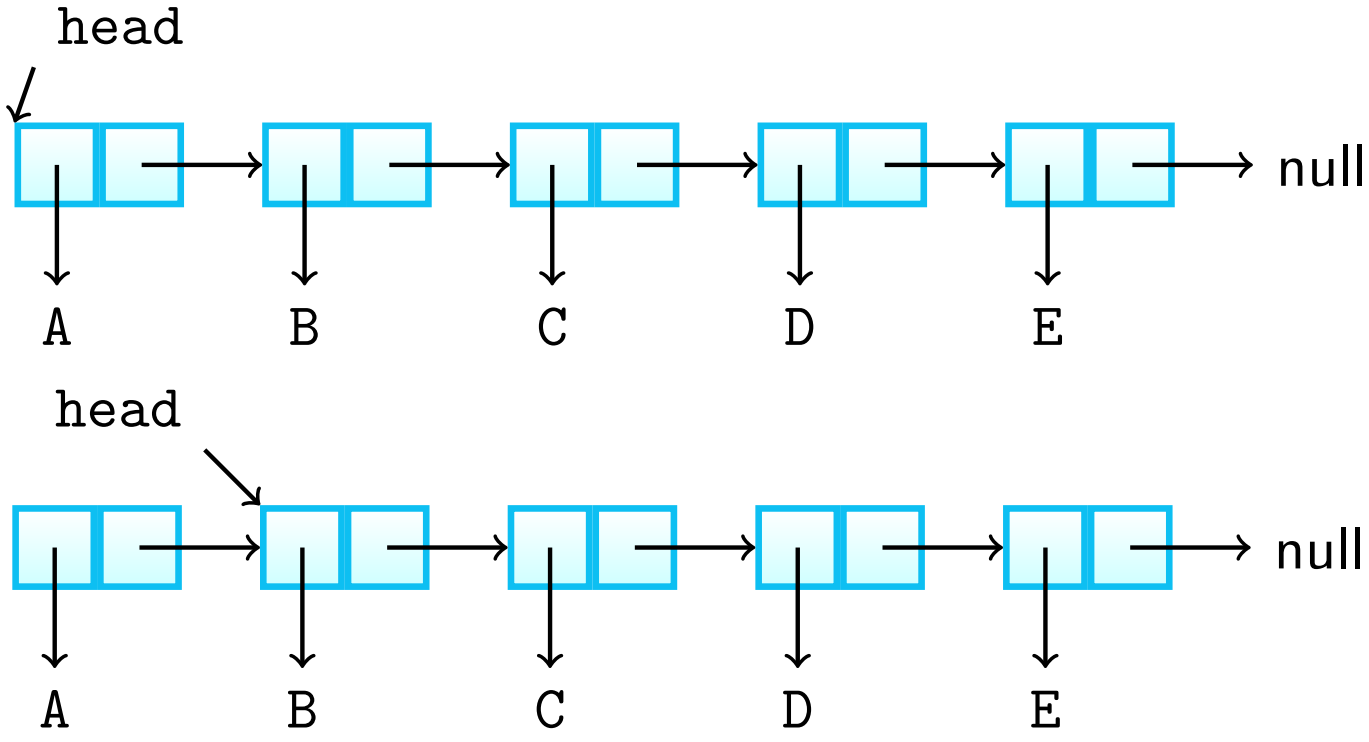

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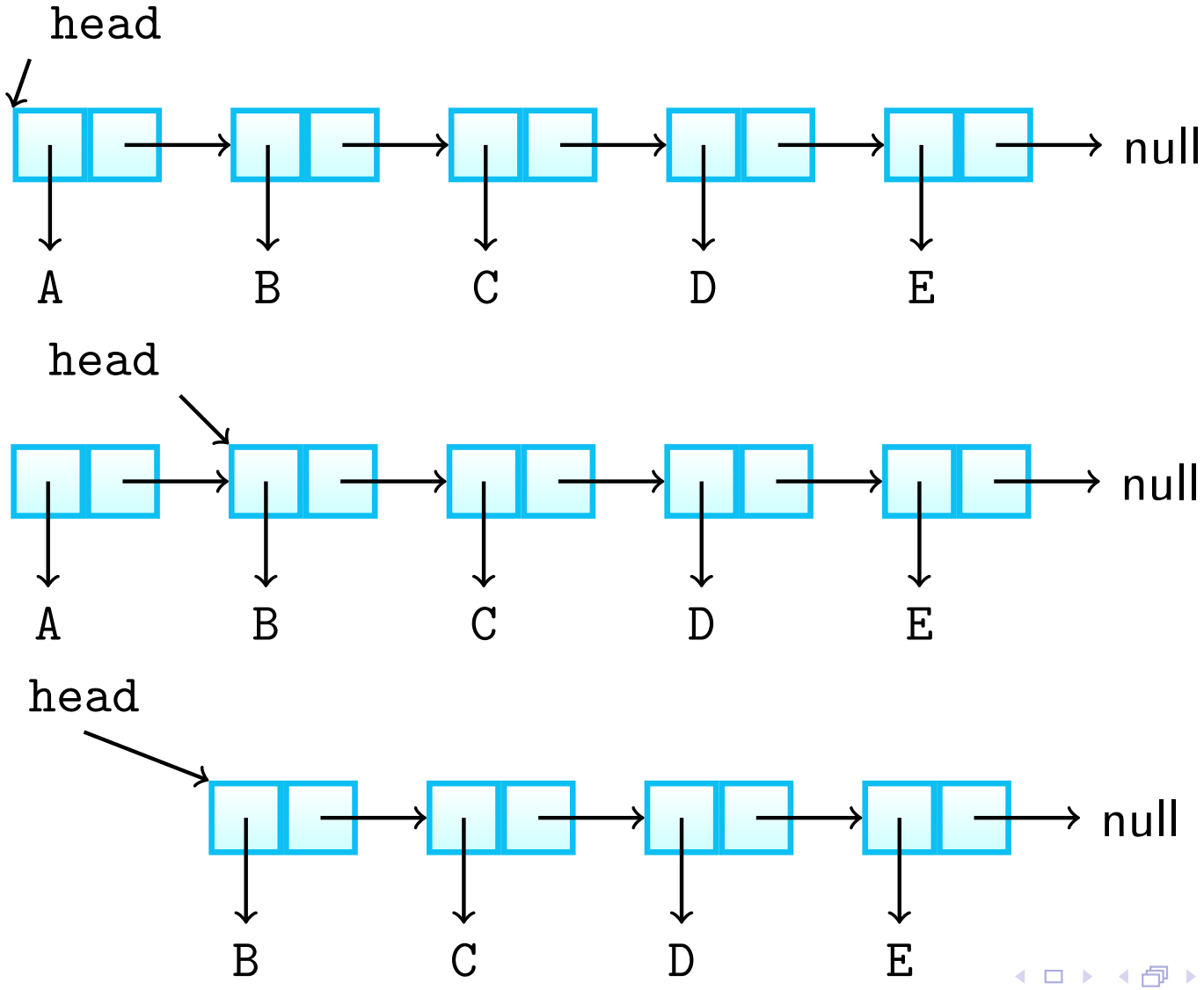

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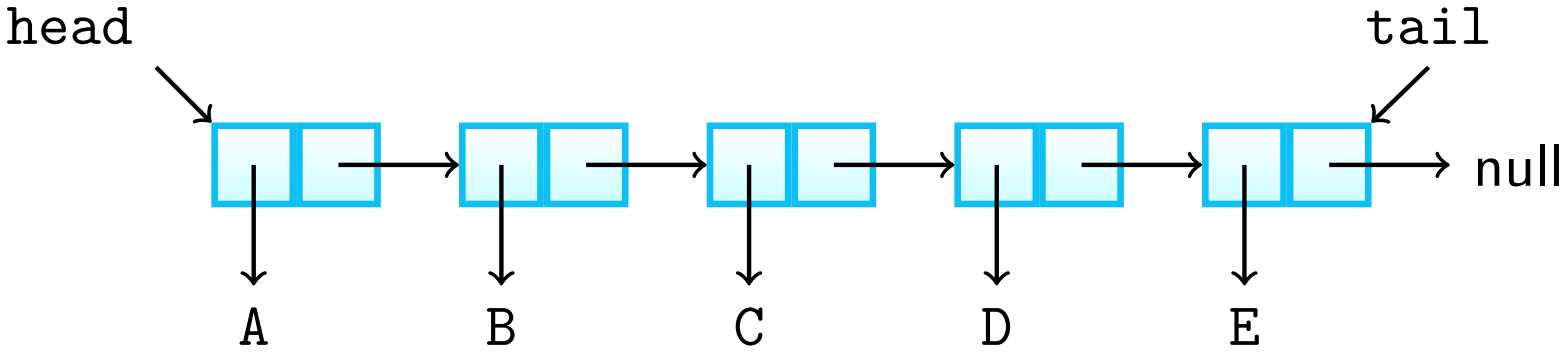
- Iterate to the node before the last node.
- Update tail (if there is a tail pointer).
- Set the current node's next reference to `null`

Removing at the Tail



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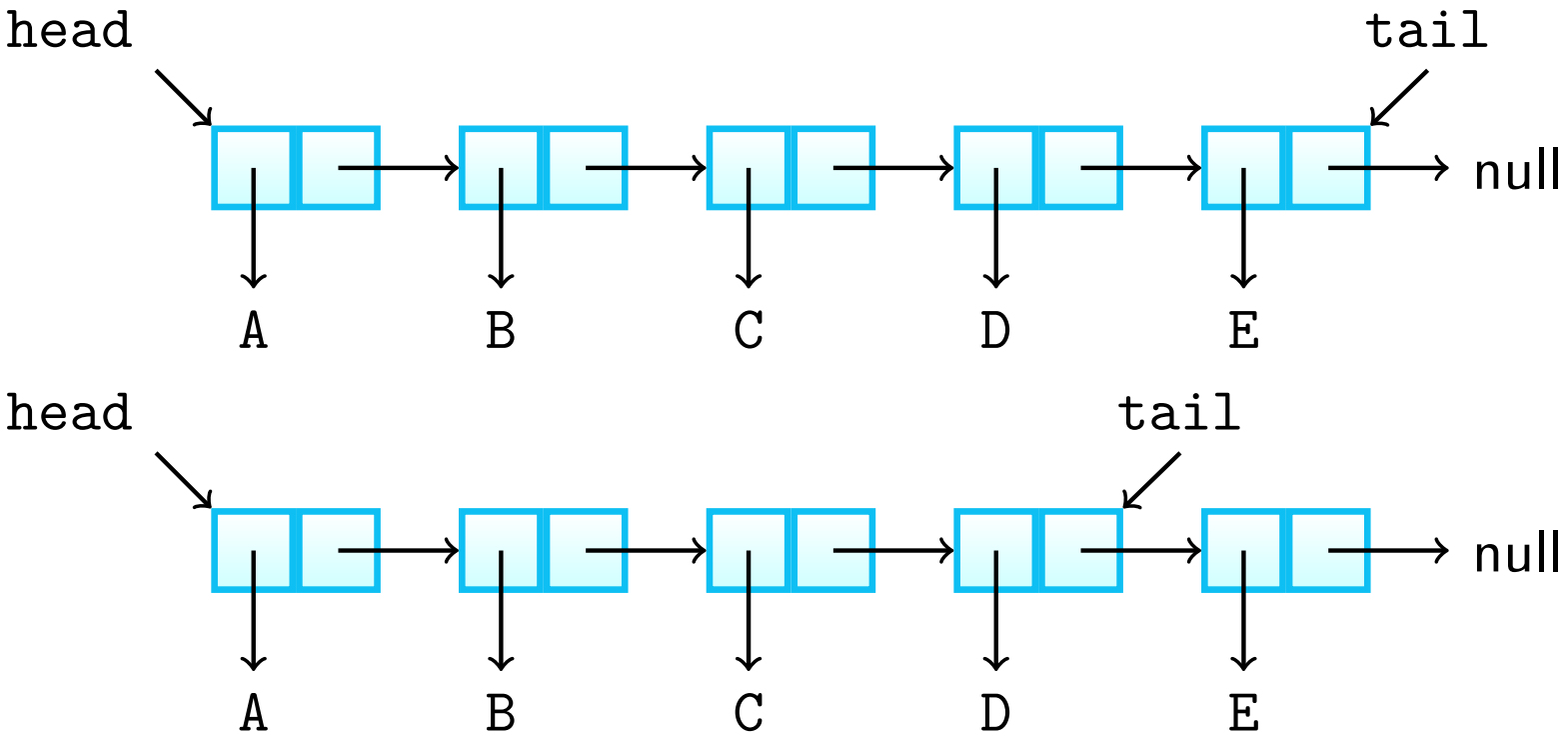

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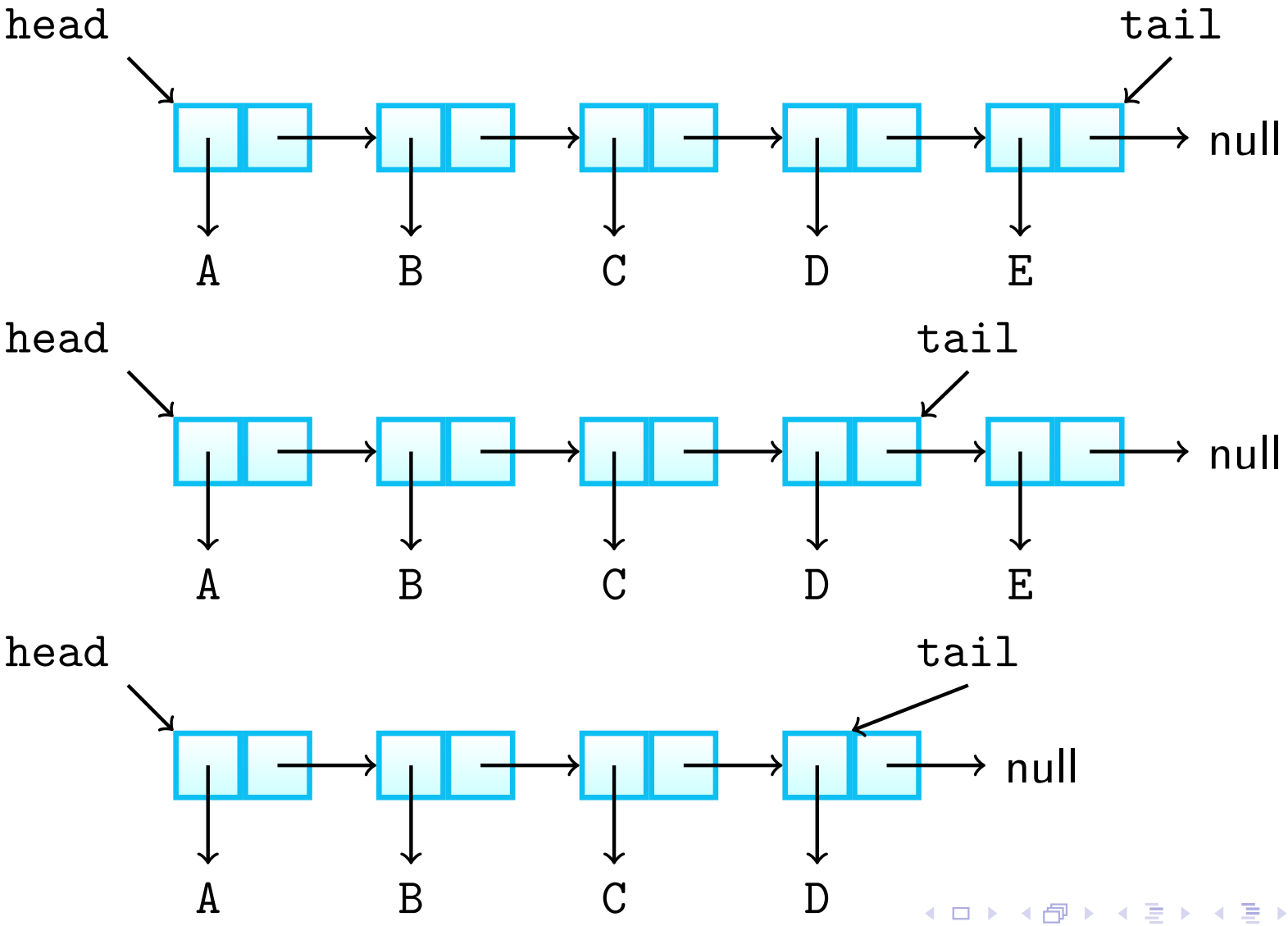

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- Examples of these are shown for doubly-linked lists.

Pseudocode For Inserting/Removing

procedure AddFirst(e)
    node $\leftarrow$ Create a new `Node` object, and have its data be *e*, and the next node be *head*
    head $\leftarrow$ *node*
    if list is empty **then**
        tail $\leftarrow$ *node*
    end if
    size $\leftarrow$ *size* $+ 1$
end procedure

Pseudocode For Inserting/Removing

procedure AddLast(e)
    node $\leftarrow$ Create a new `Node` object, and have its data be *e*
    if list is empty **then**
        head $\leftarrow$ *node*
    else
        tail.*next* $\leftarrow$ *node*
    end if
    tail $\leftarrow$ *node*
    size $\leftarrow$ *size* $+ 1$
end procedure

Pseudocode For Inserting/Removing

procedure REMOVEFIRST(e)
    node $\leftarrow$ *head*
    head $\leftarrow$ *head*.*next*
    size $\leftarrow$ *size* $-$ 1
    return *node*
end procedure

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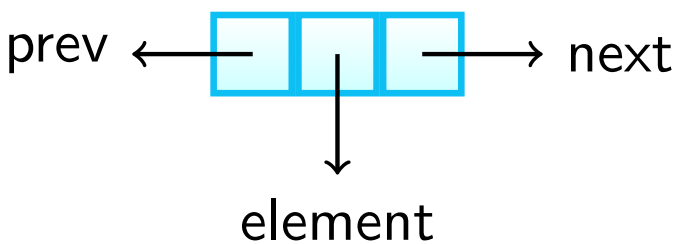


Generic Code For Doubly Linked List Node

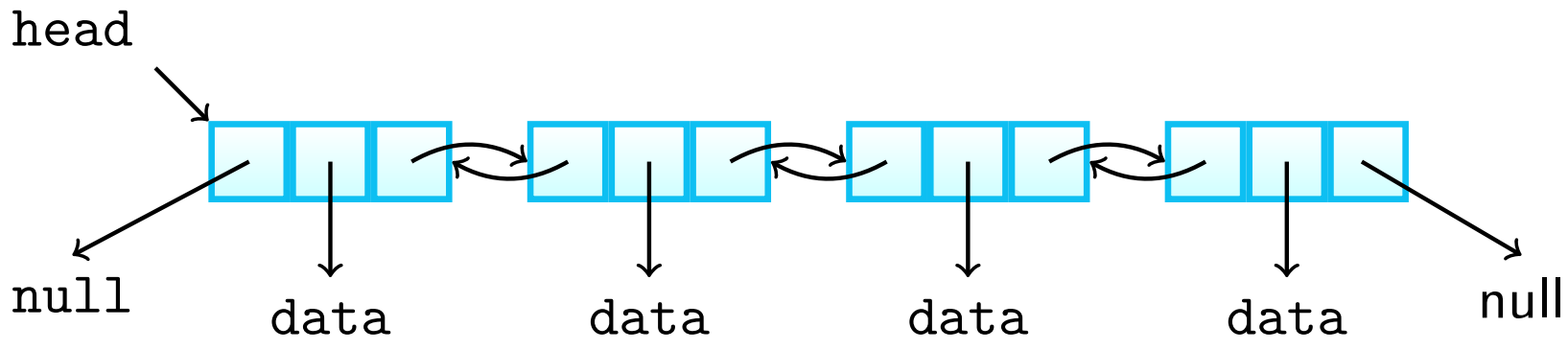
```
public class DoublyLinkedList<Type> {
    private class Node<Type> {
        private Type data;
        private Node<Type> next;
        private Node<Type> prev;

        private Node(Type data, Node<Type> next,
          Node<Type> prev) {
            this.data = data;
            this.next = next;
            this.prev = prev;
        }
    }
}
```

Generic Code For Doubly Linked List Node

```
// Node constructor chaining
private Node(Type data) {
    this(data, null, null)
// this.data = data
// this.next = null
// this.prev = null
}
```

Doubly Linked List

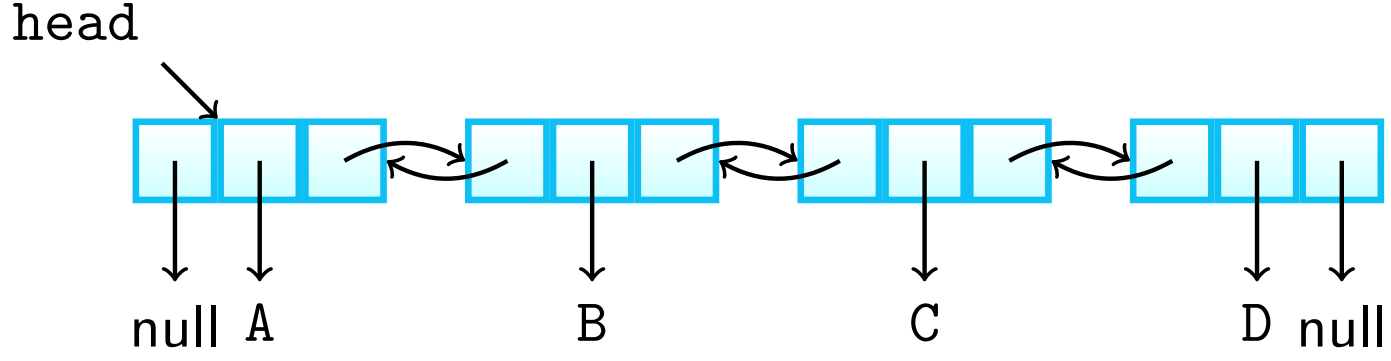
Example of a doubly linked list:



Notice that `prev` reference of the first node points to `null`, as does the `next` reference of the last node

Insertion

Create new node `X`. Insert a new node, `X`, between node `C` and node `D`. Set new node's `prev` reference to `C` and `next` reference to `D`.



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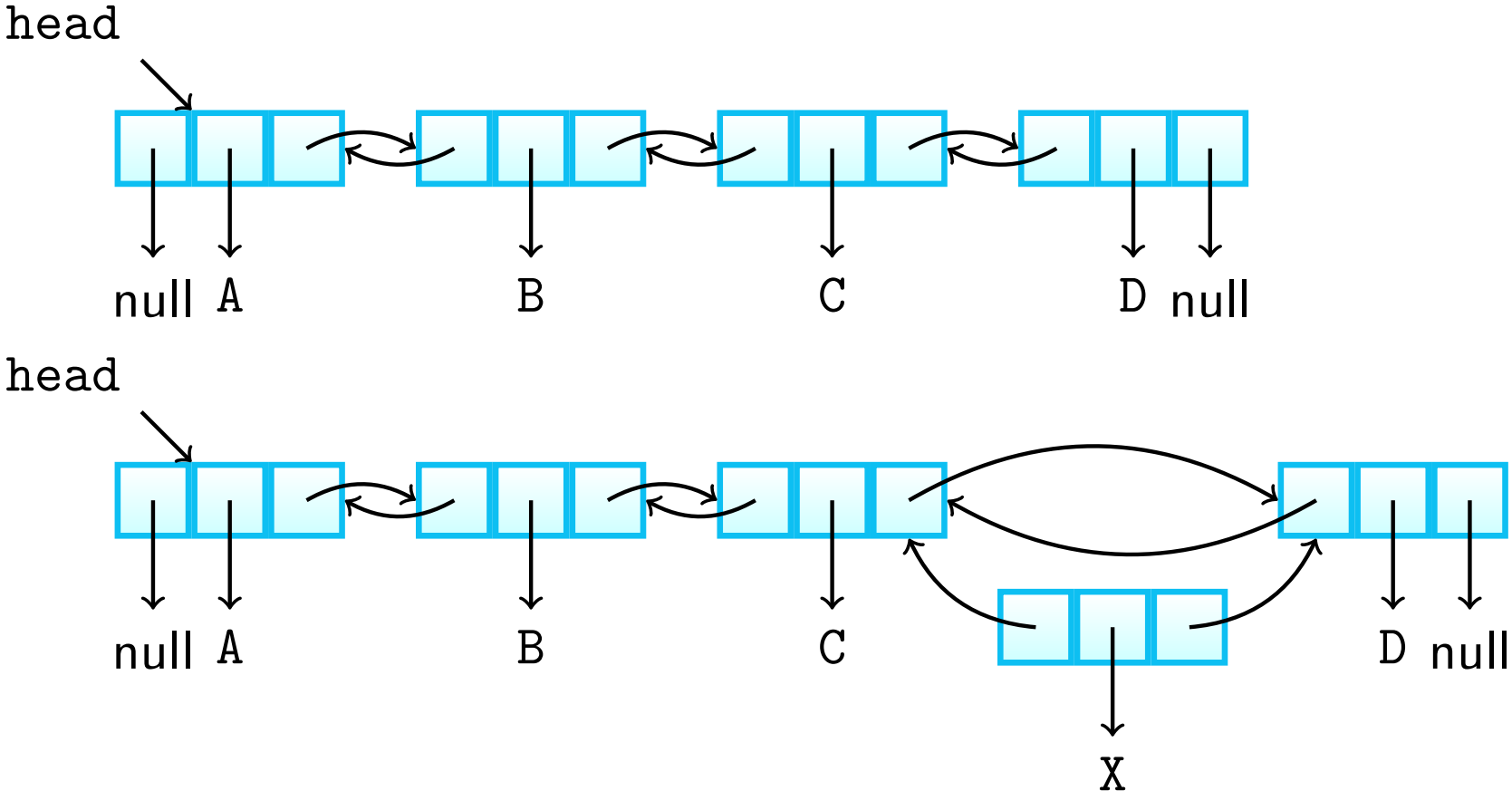

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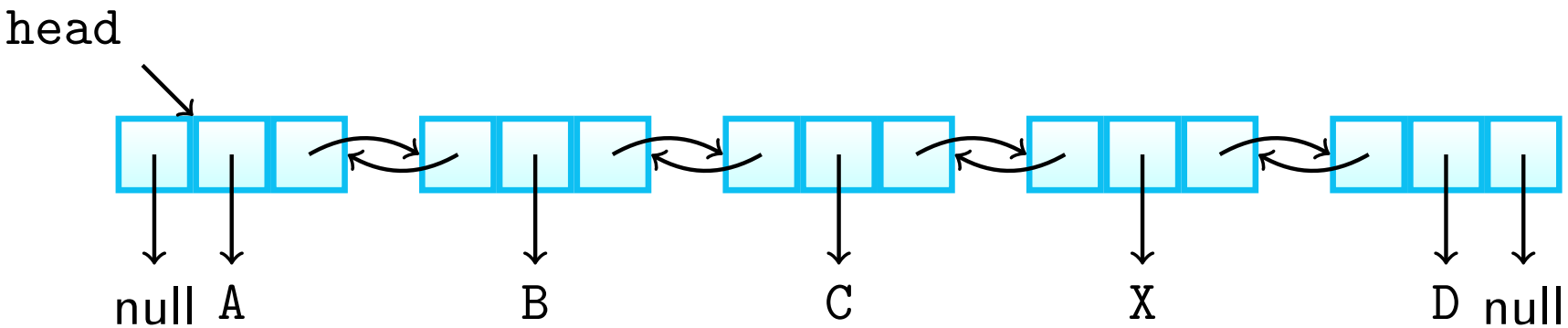
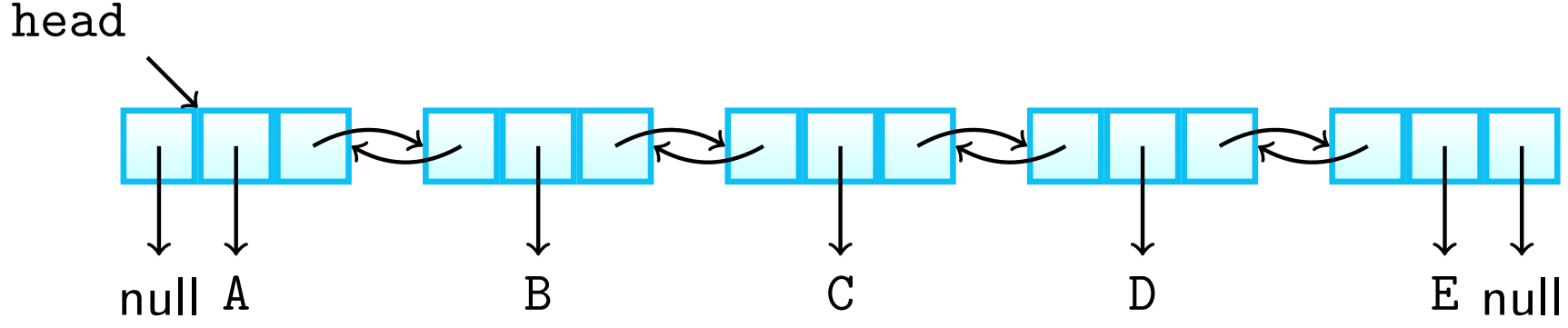


Once node `X` is connected, set Node `C`'s `next` reference to node `X`, and Node `D`'s `prev` reference to node `X`.

Deletion

Remove node D, between nodes C and E. The order in which you redirect references is important so you do not lose your linked list.



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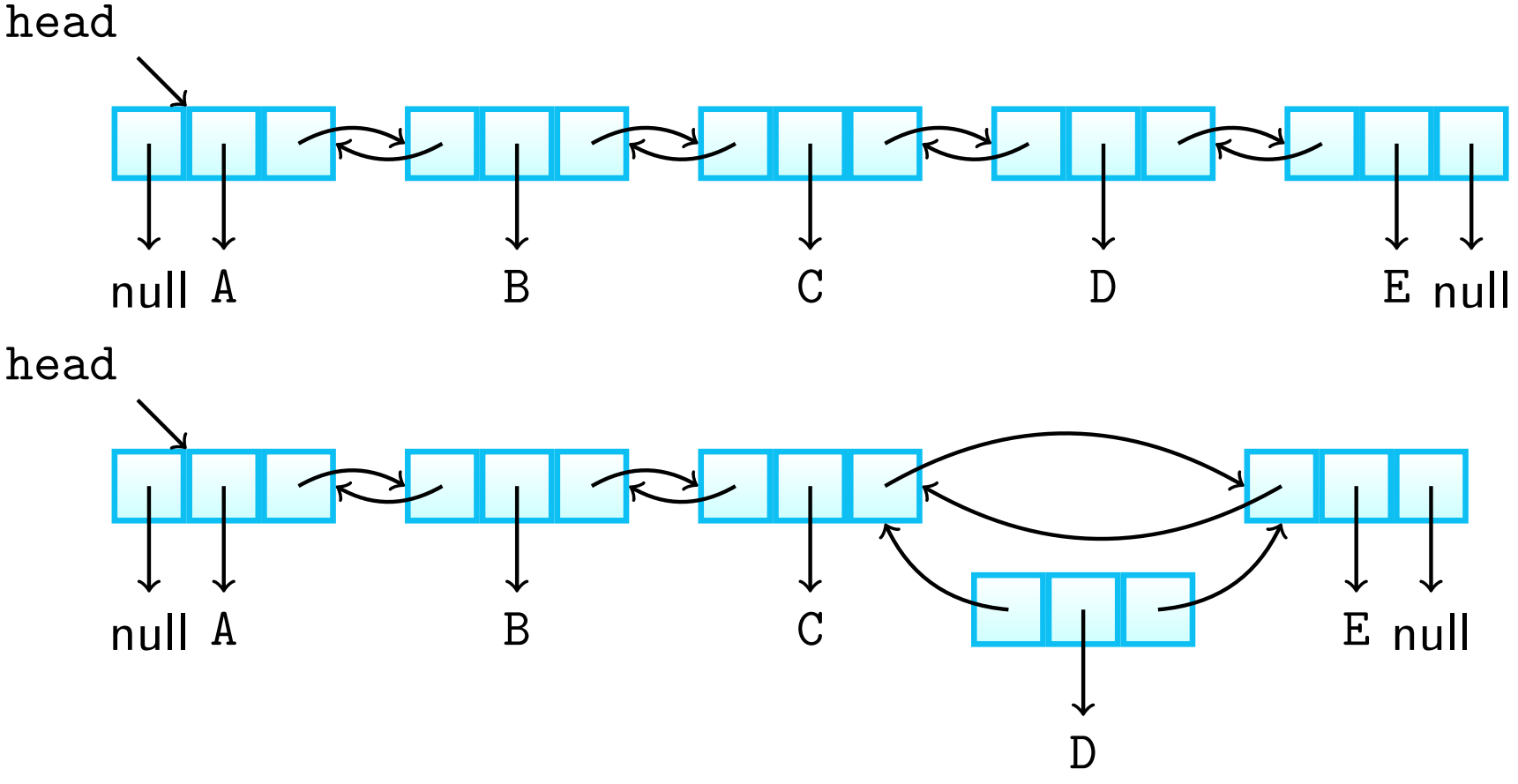
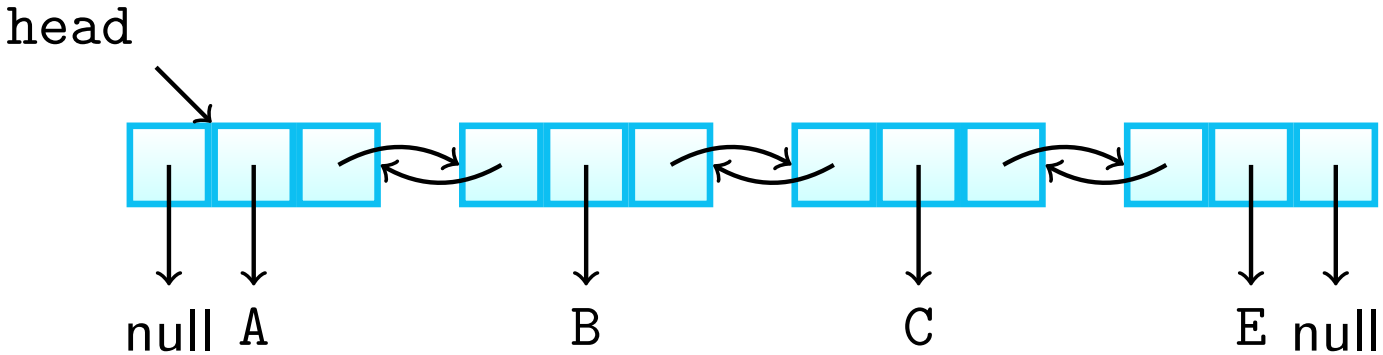


Deletion

Set node `C`'s `next` reference to node `E`, and node `E`'s `prev` reference to `C`. Node `D` will be garbage collected.



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- Singly linked lists are used in RFID scanning, app wizards or levels in a video game
- Doubly linked lists are used in browser history, scroll bars or forward/back buttons

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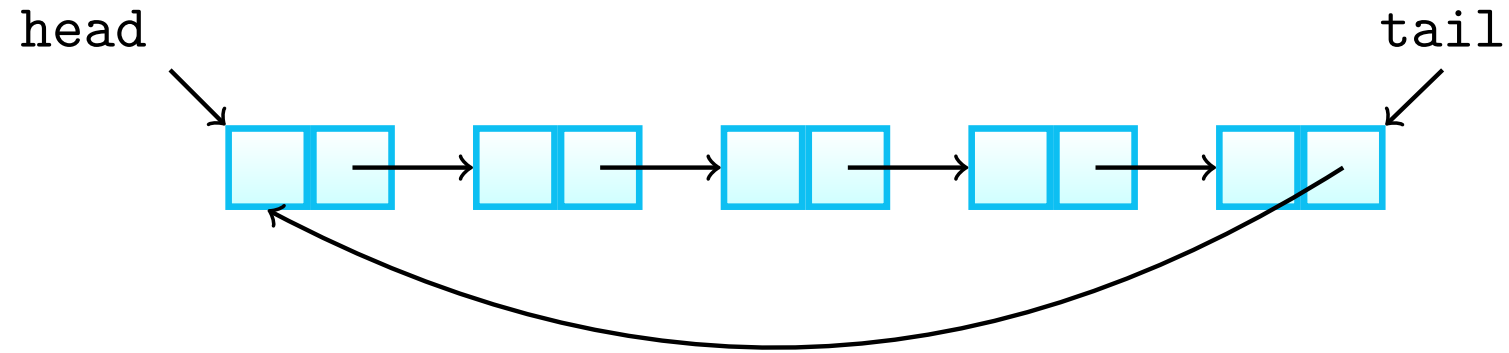
- Circular linked lists can be either singly or doubly linked.
- Depending on single or double links, adding or removing is the same as for the type of link
- Applications that use circular linked lists are gifs, music playlists; round-robin scheduling algorithms for operating systems

Circular Linked Lists

Example of Singly Circular Linked List



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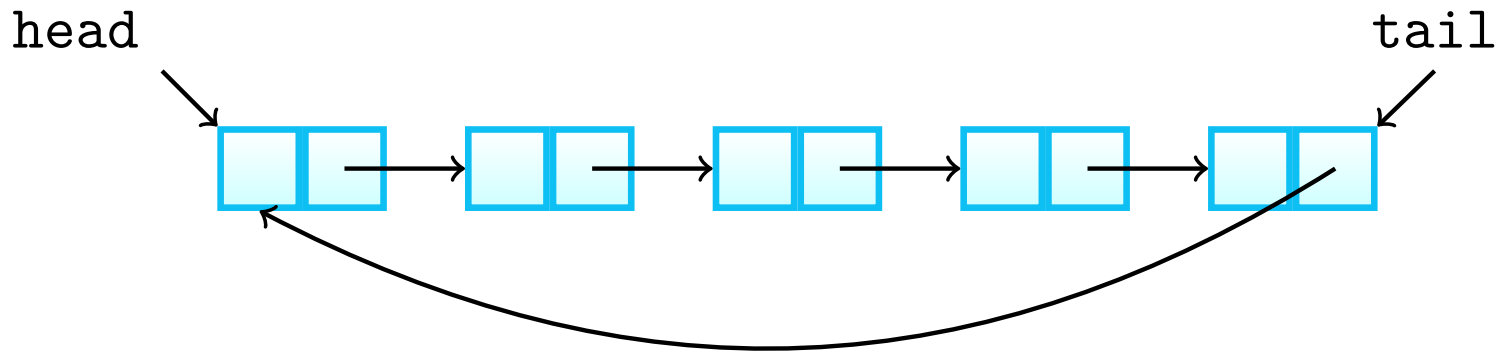

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