Linked Lists

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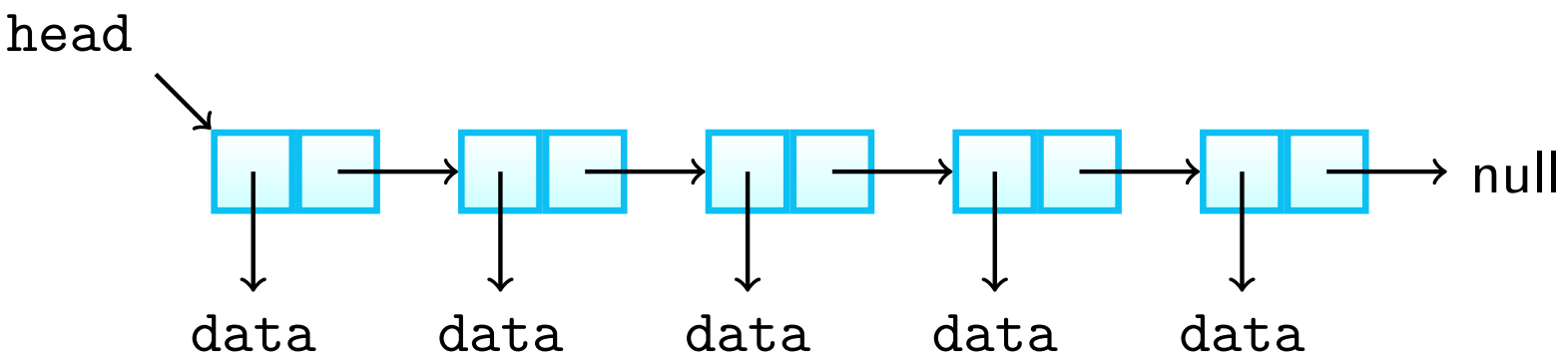
Recall Linked Lists

- A linked list is a data structure consisting of a sequence of nodes.
- Each node in the linked list stores the data and a pointer to the next/previous node(s).
- 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.
- Linked list have a head pointer, and may have a tail pointer.

Recall Singly Linked Lists

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.



Doubly Linked List

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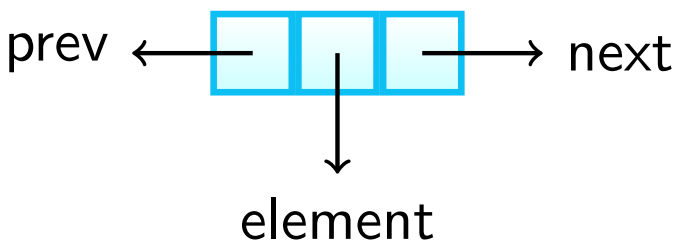


Generic Code For Doubly Linked List Node

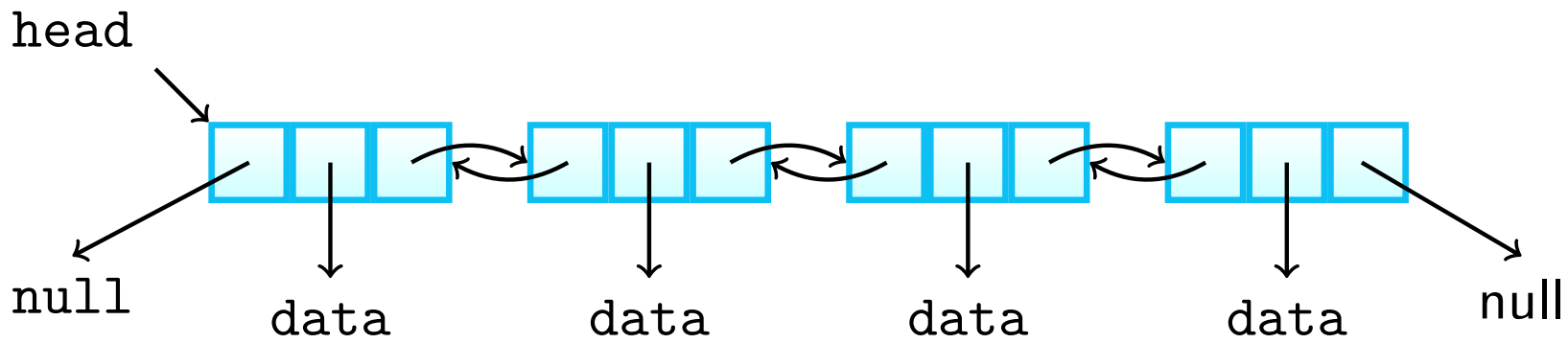
```
public class DoublyLinkedList<Type> {
    private class Node<Type> {
        private Type data;
        private Node<Type> next;
        private Node<Type> prev;

        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

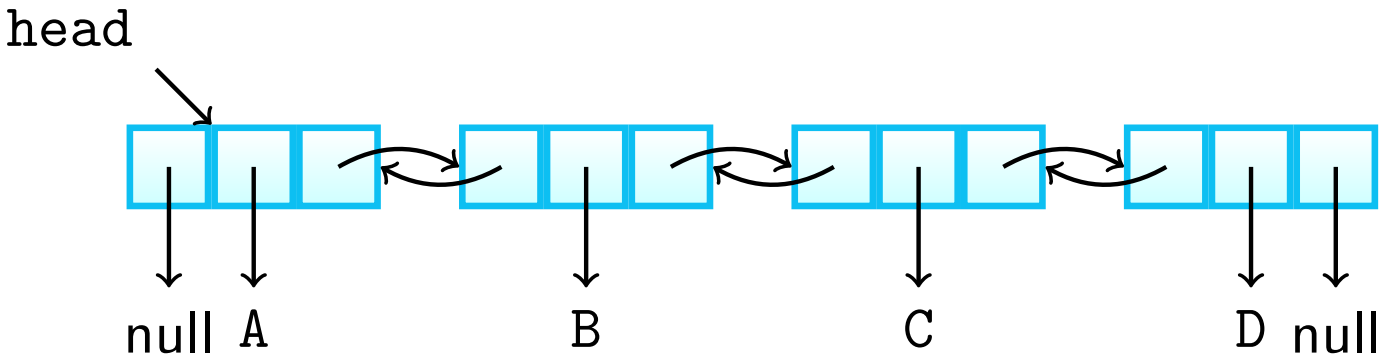
Example of a doubly linked list:



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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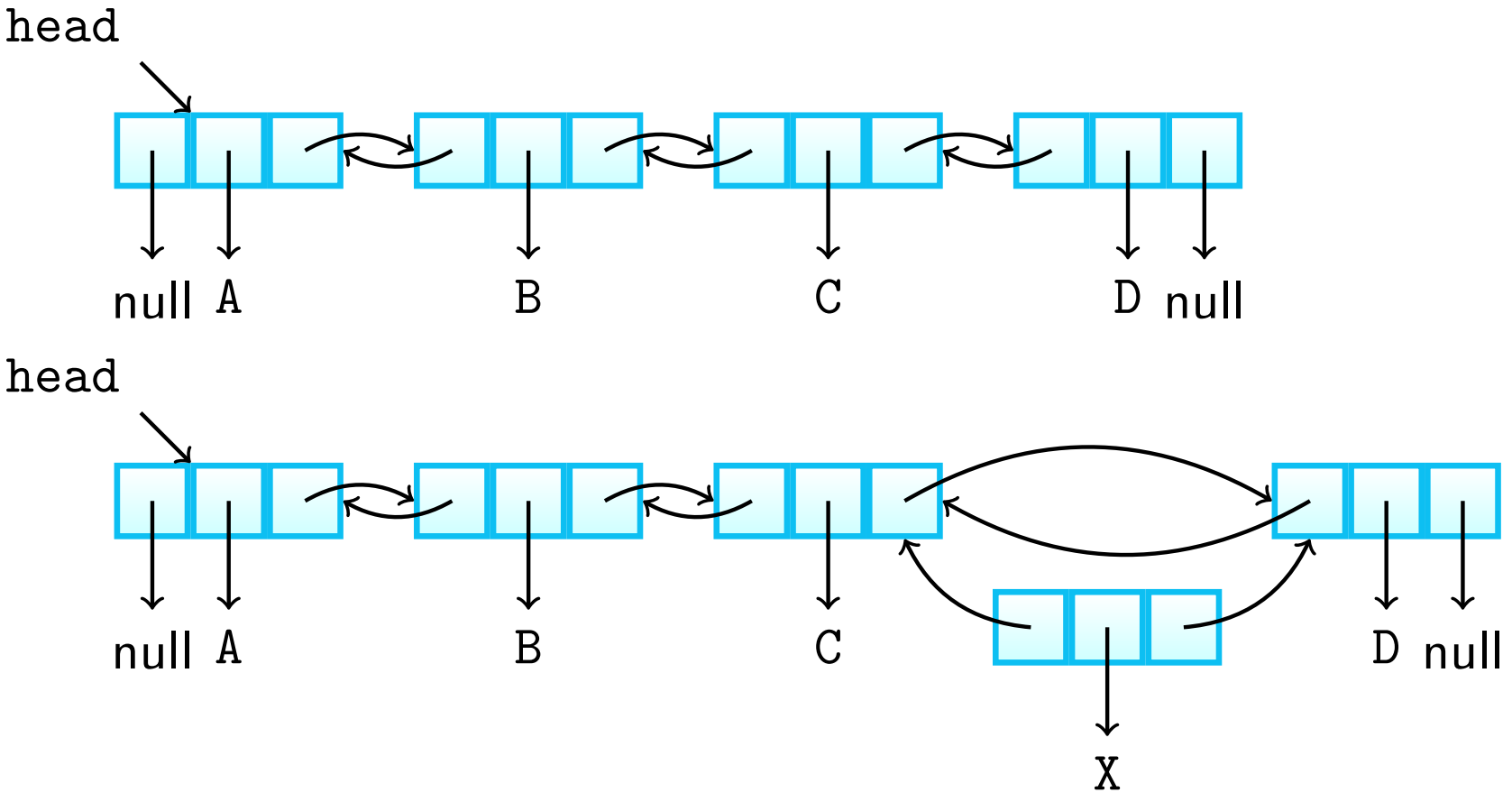

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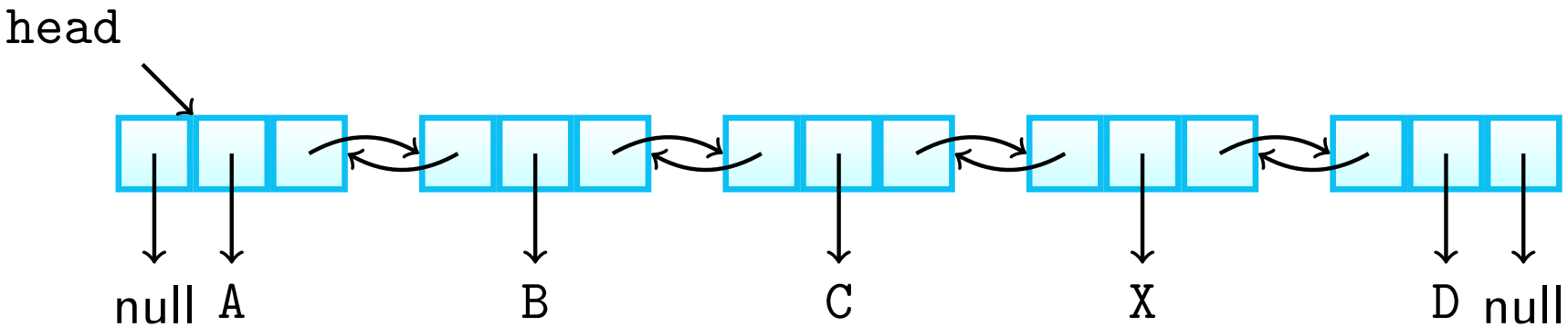
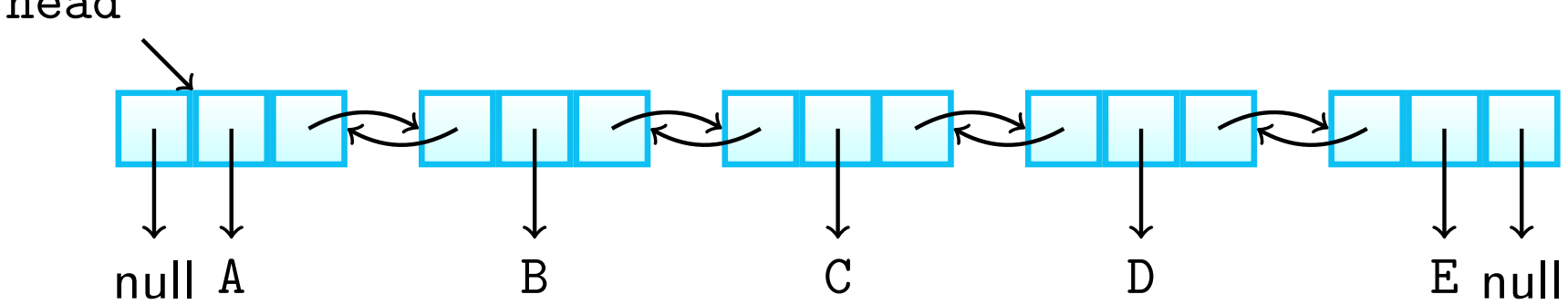


Once node `X` is connected, set Node `C`'s `next` reference to node `X`, and Node `D`'s `prev` reference to node `X`.

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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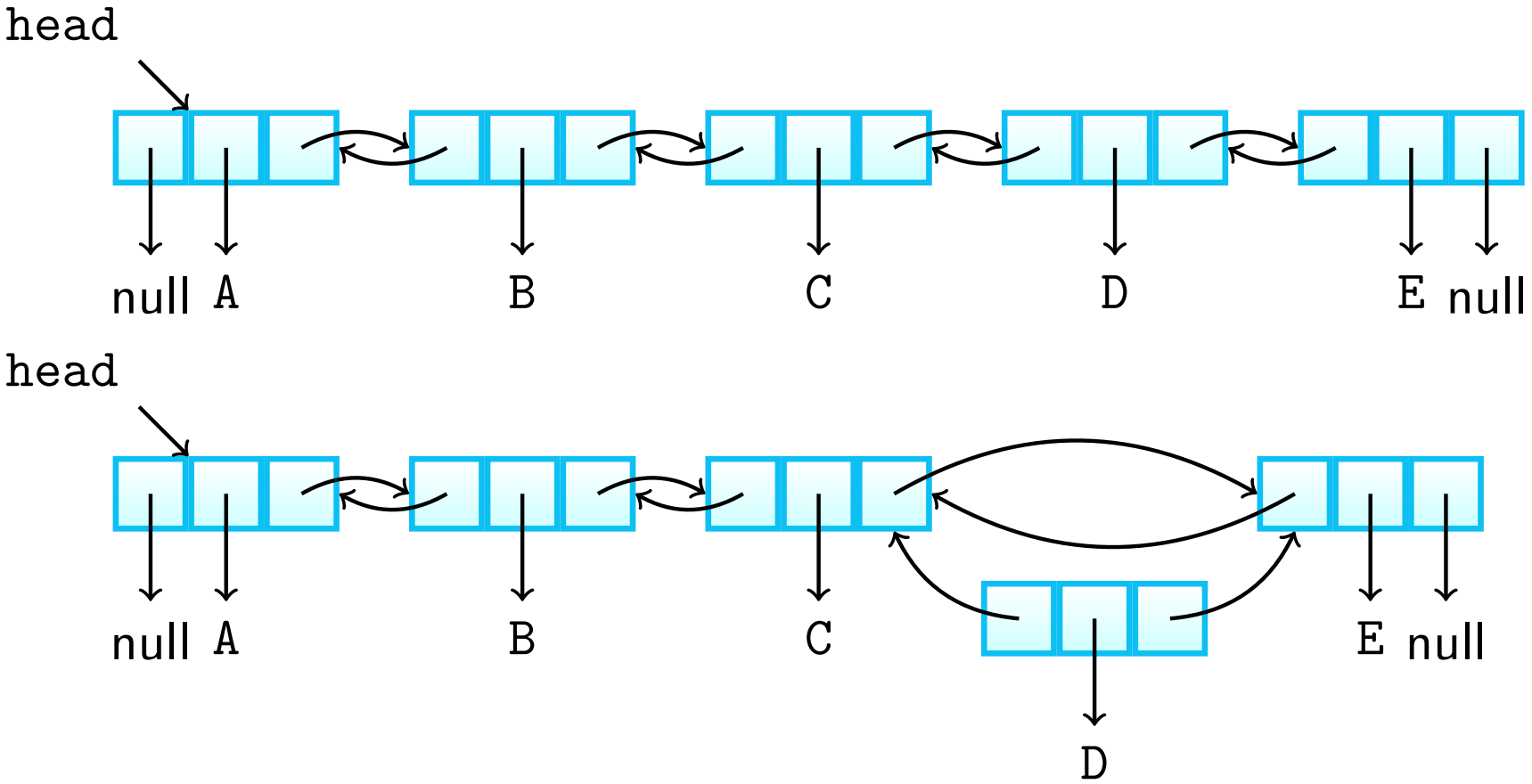
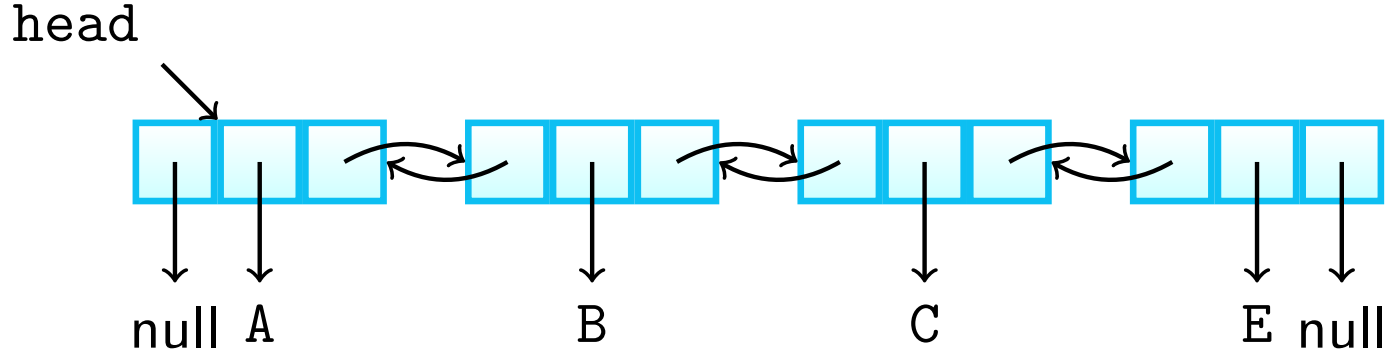


Deletion

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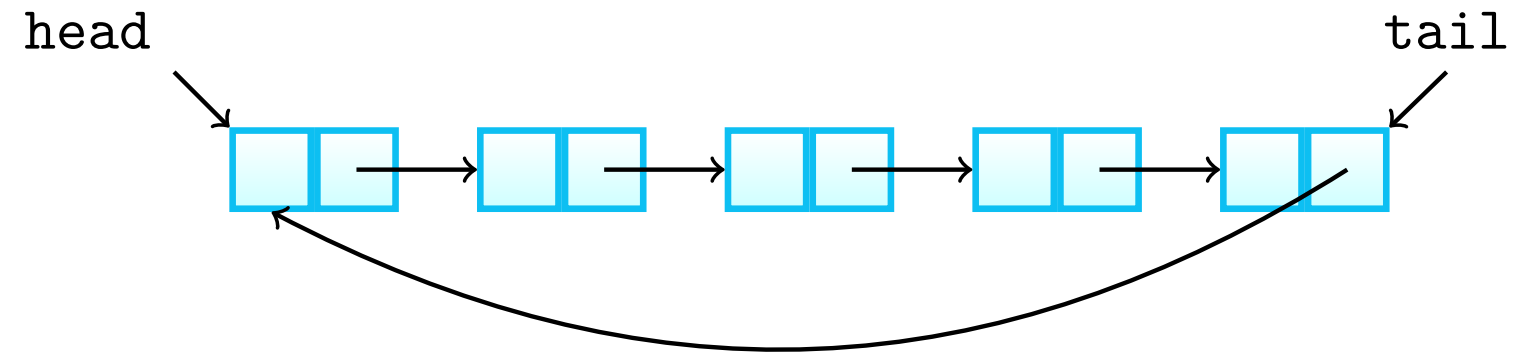
- Circular linked lists can be either singly or doubly linked.
- Depending on single or double links, adding or removing is the same as for the type of link
- Applications that use circular linked lists are gifs, music playlists; round-robin scheduling algorithms for operating systems

Circular Linked Lists

Example of Singly Circular Linked List



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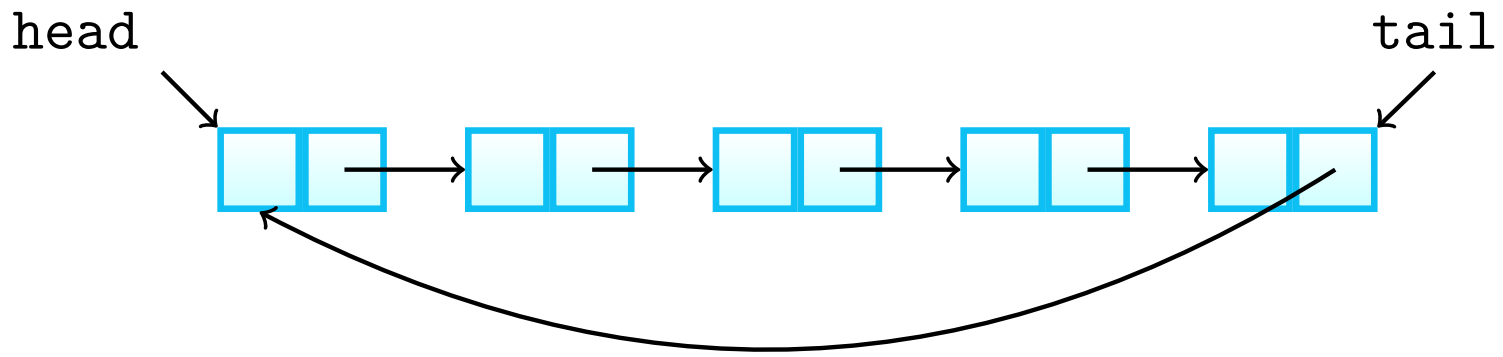

Example of Doubly Circular Linked List