The Linked List

CS 214, Fall 2019

A problem with vectors

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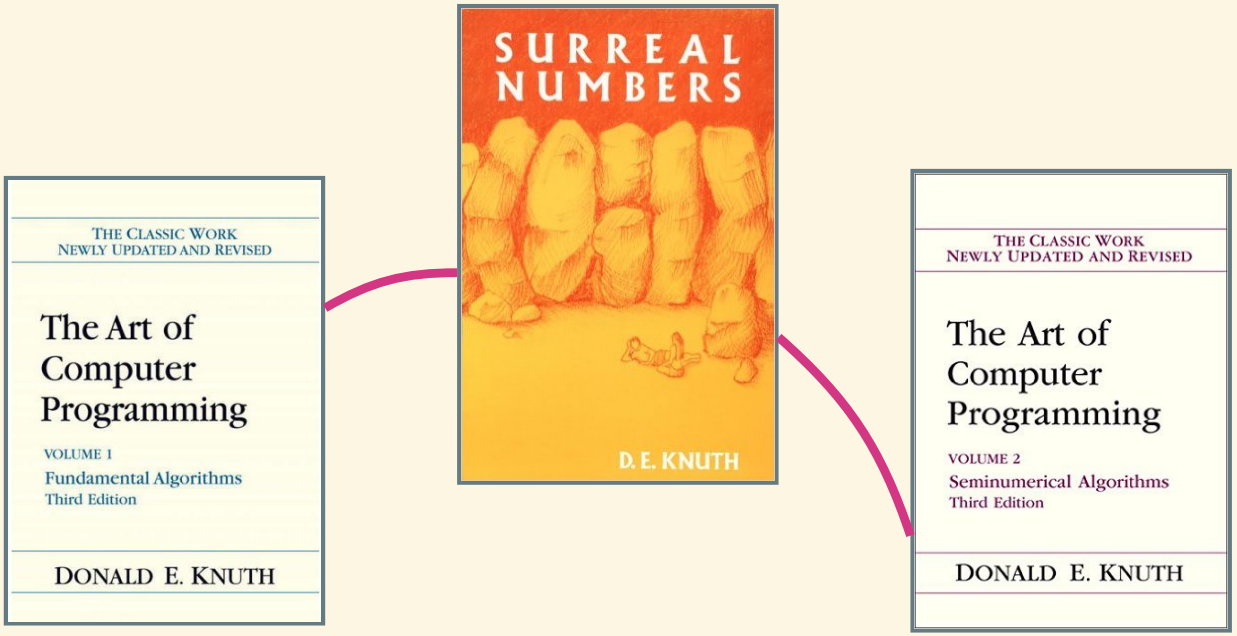
No can do! Elements 7, 8, 9, 10, and 11 are all in the way, and the vector is full.

Need to create a new, bigger vector, and copy everything over…

Books on a string



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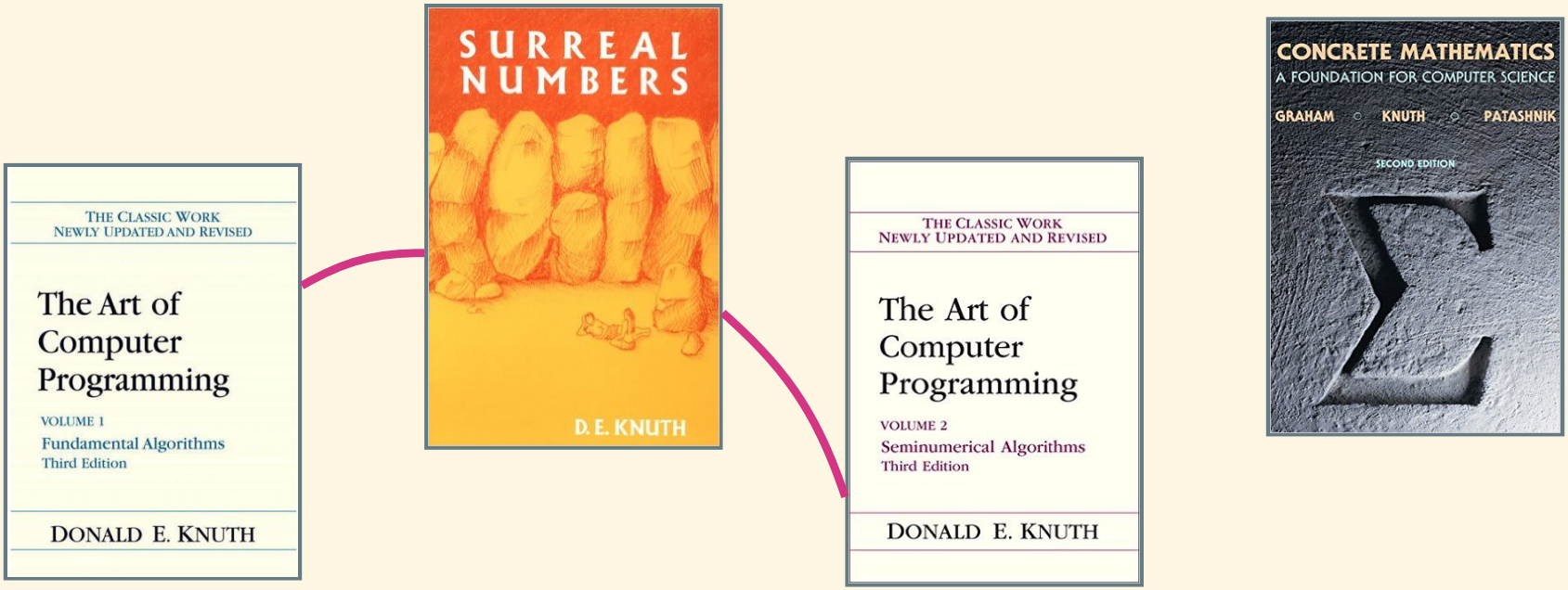

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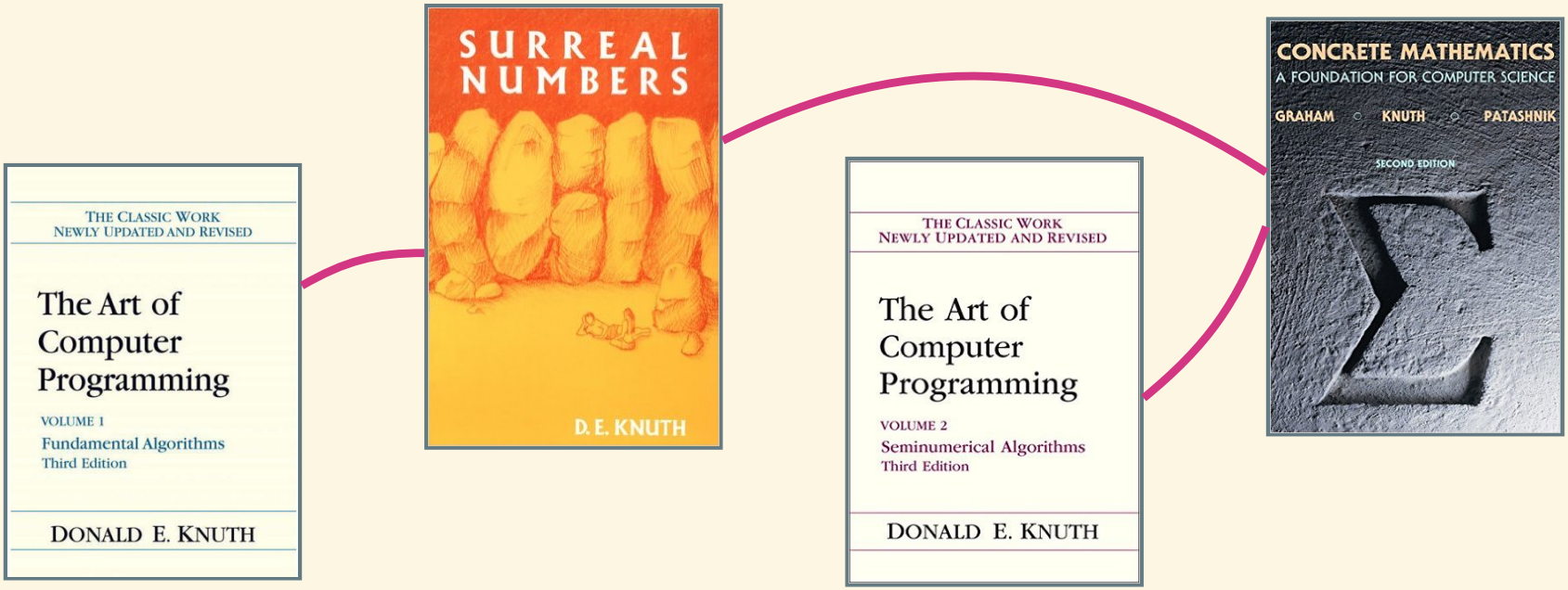


Nodes and pointers

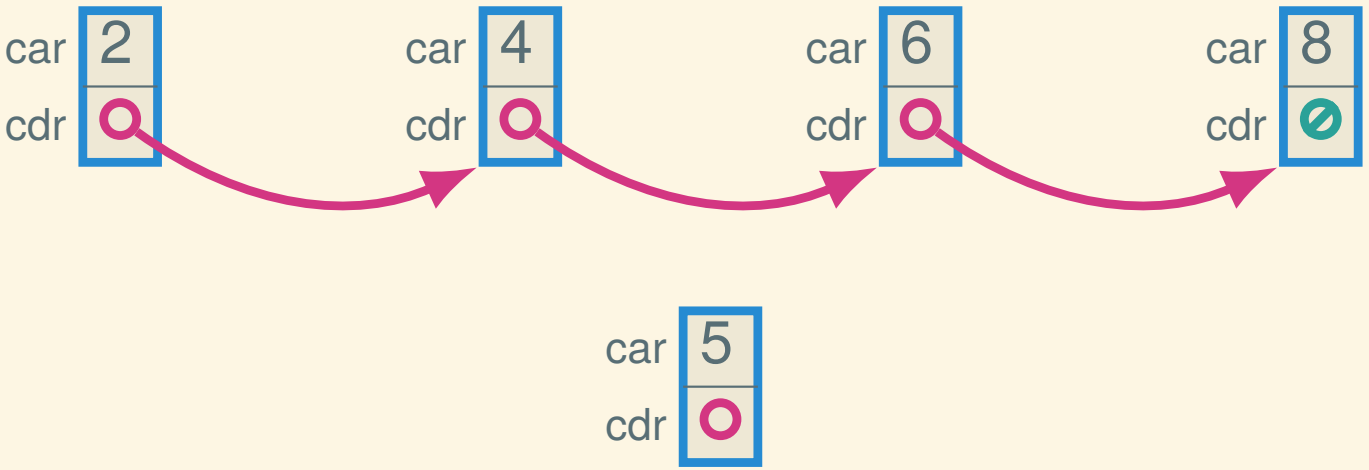
You saw `cons` in 111.

- `car` holds the *first* element, and
- `cdr` holds a pointer to the *rest* of the list.

Nodes and pointers

Inserting in the middle? No problem!

Just change the pointers



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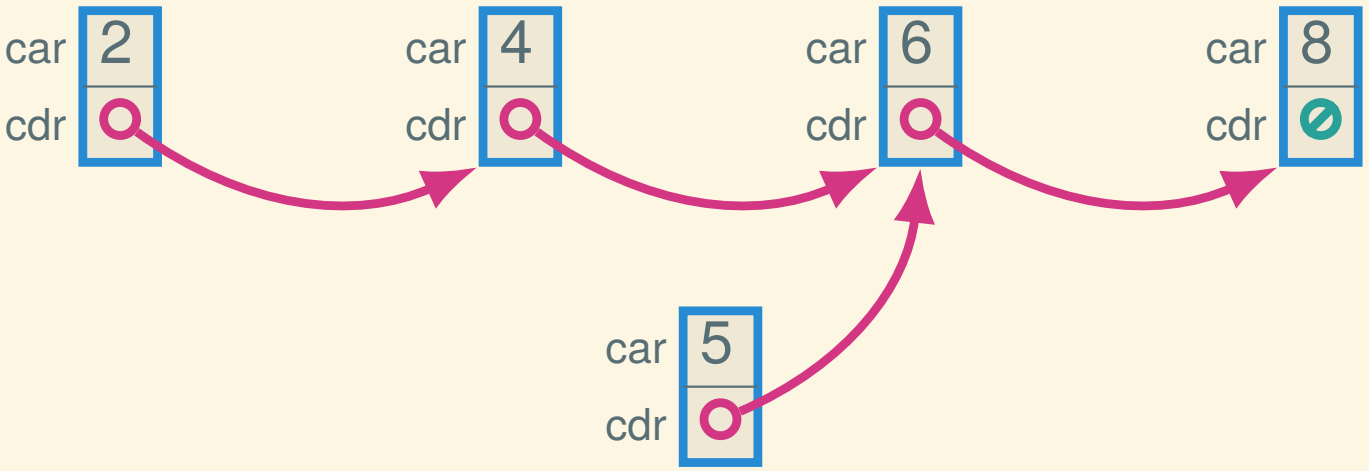

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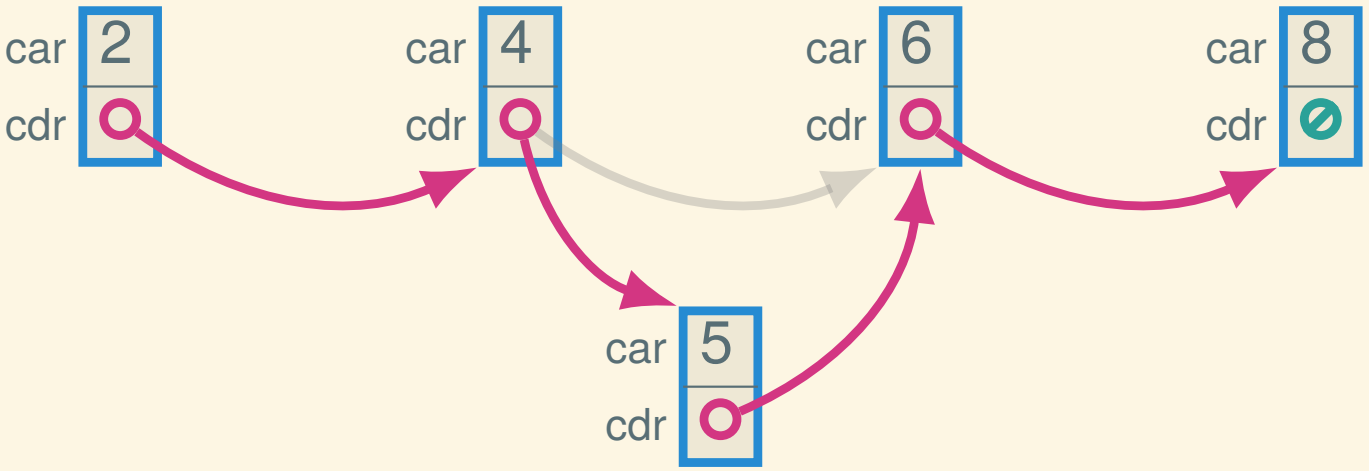

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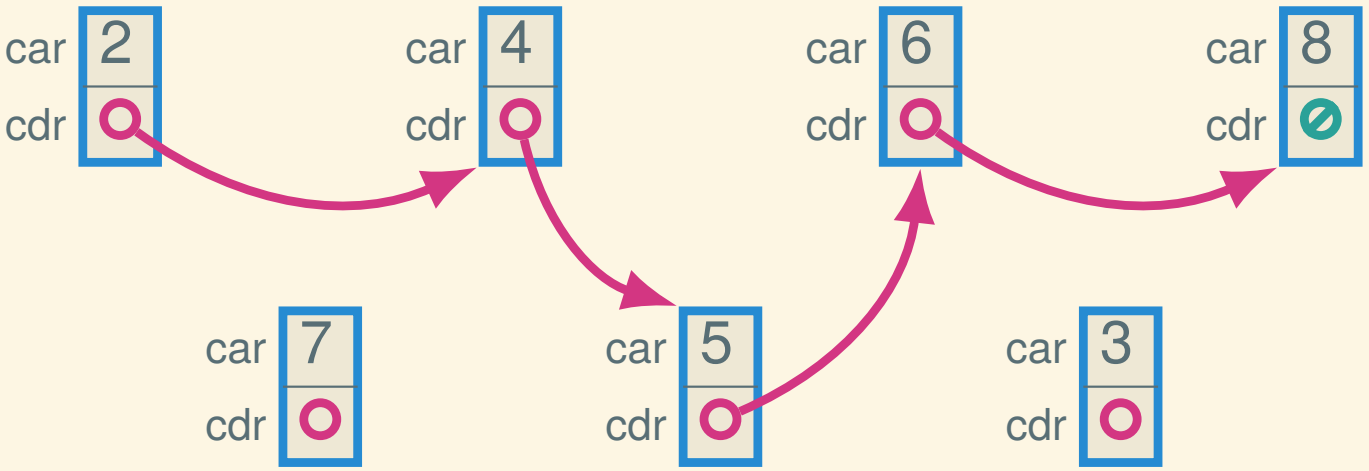

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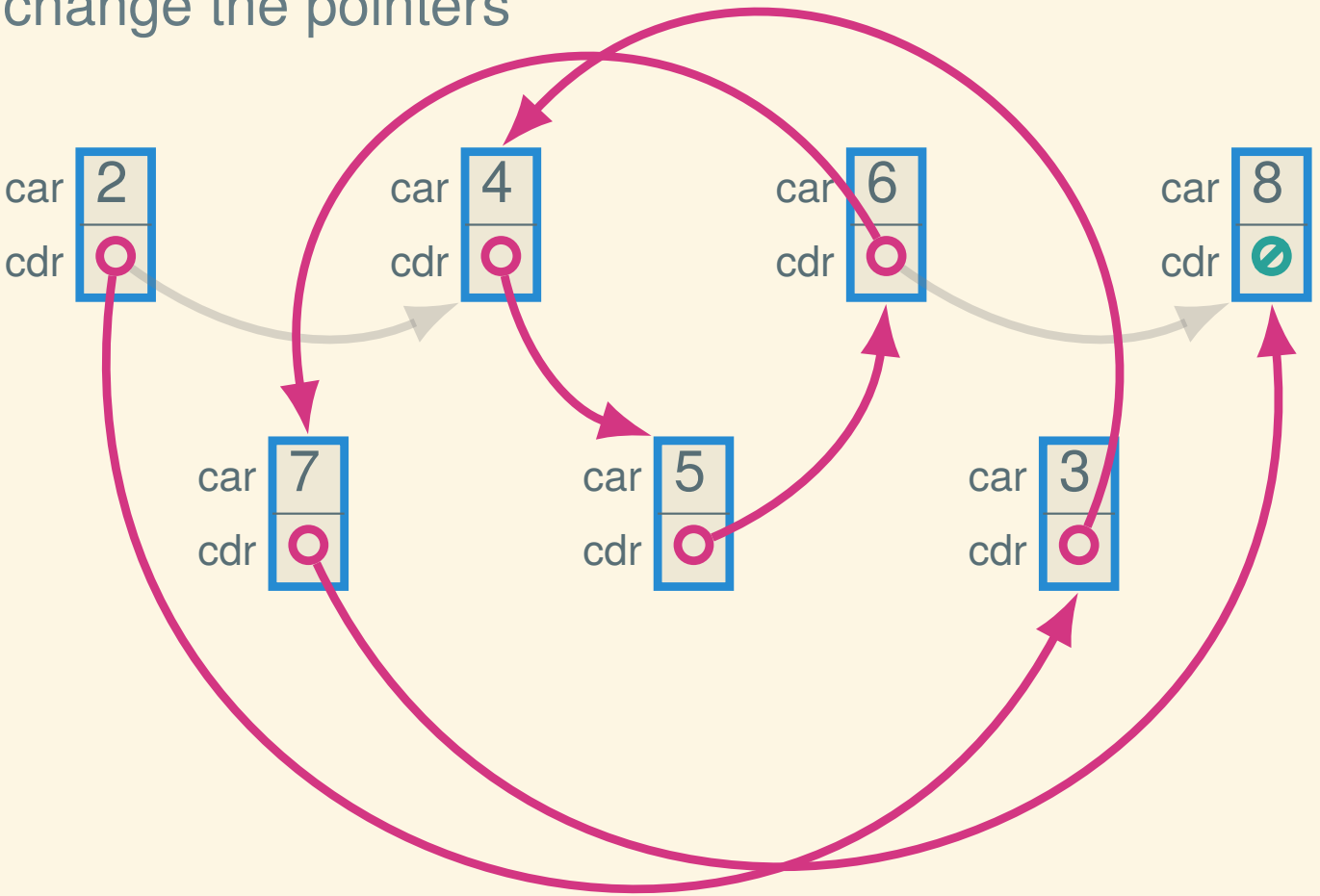
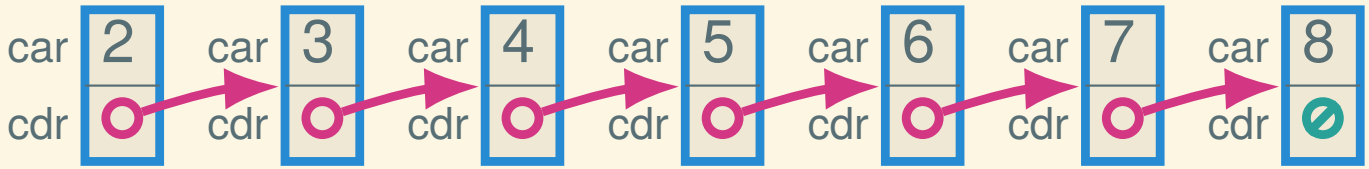


Inserting at the beginning



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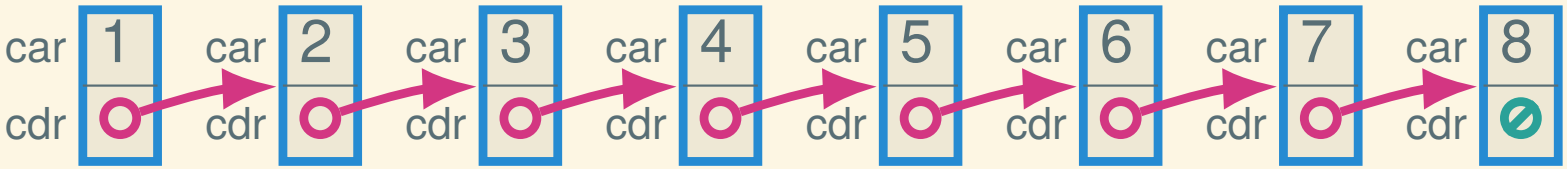

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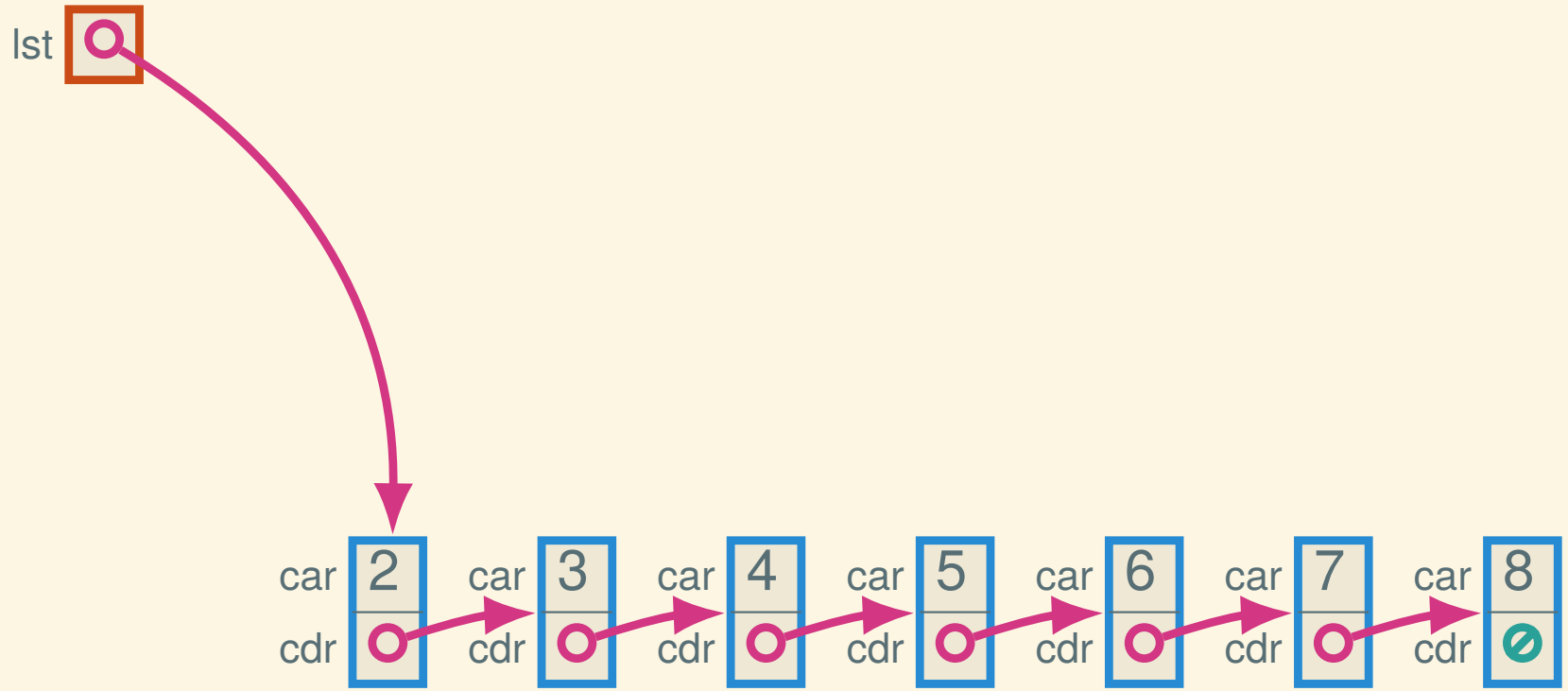

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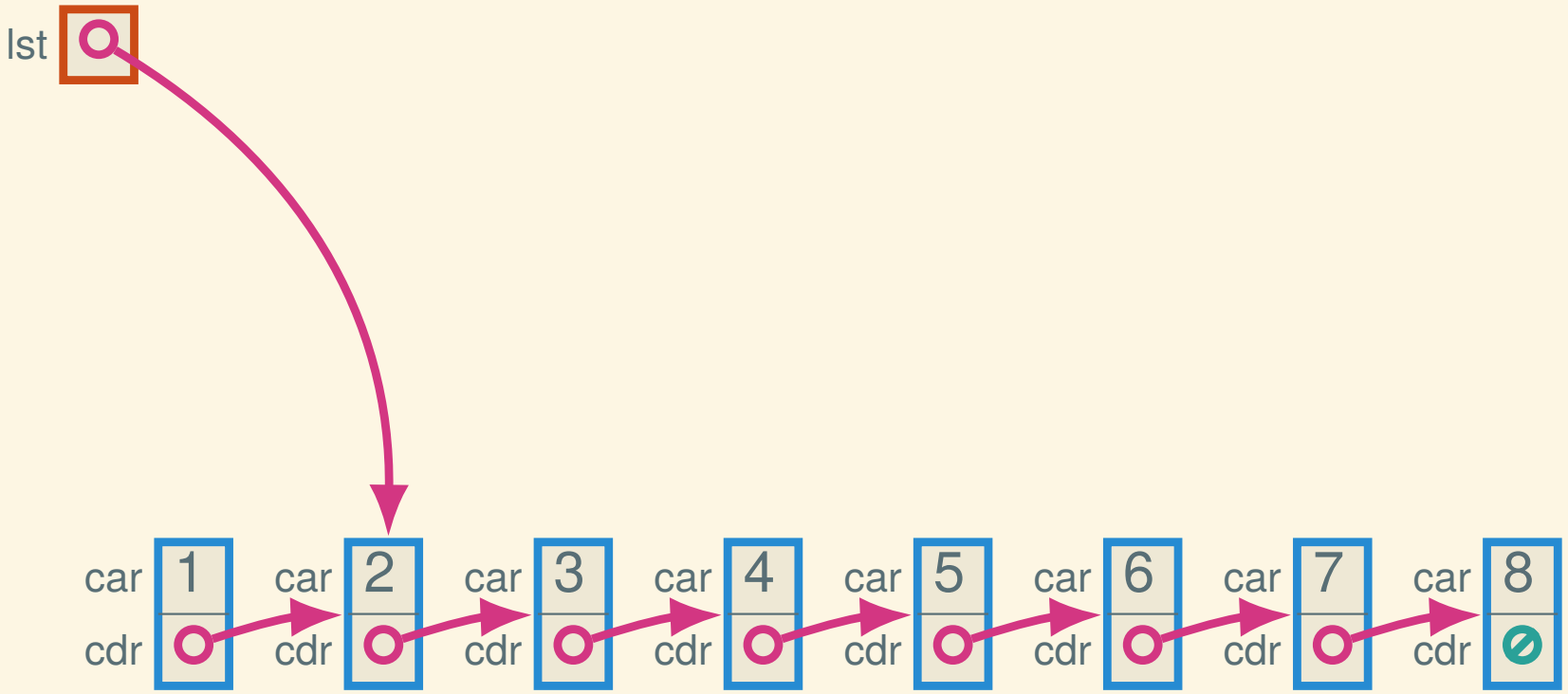

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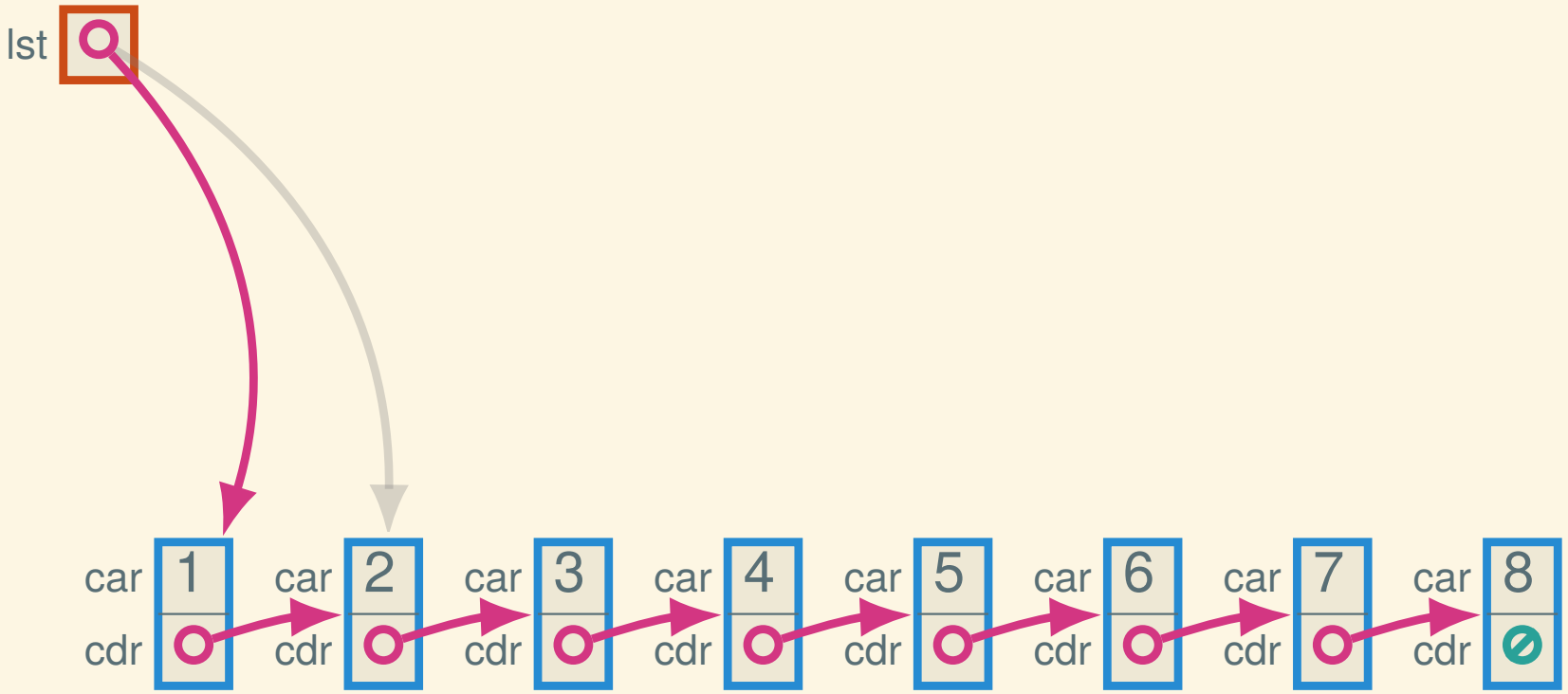
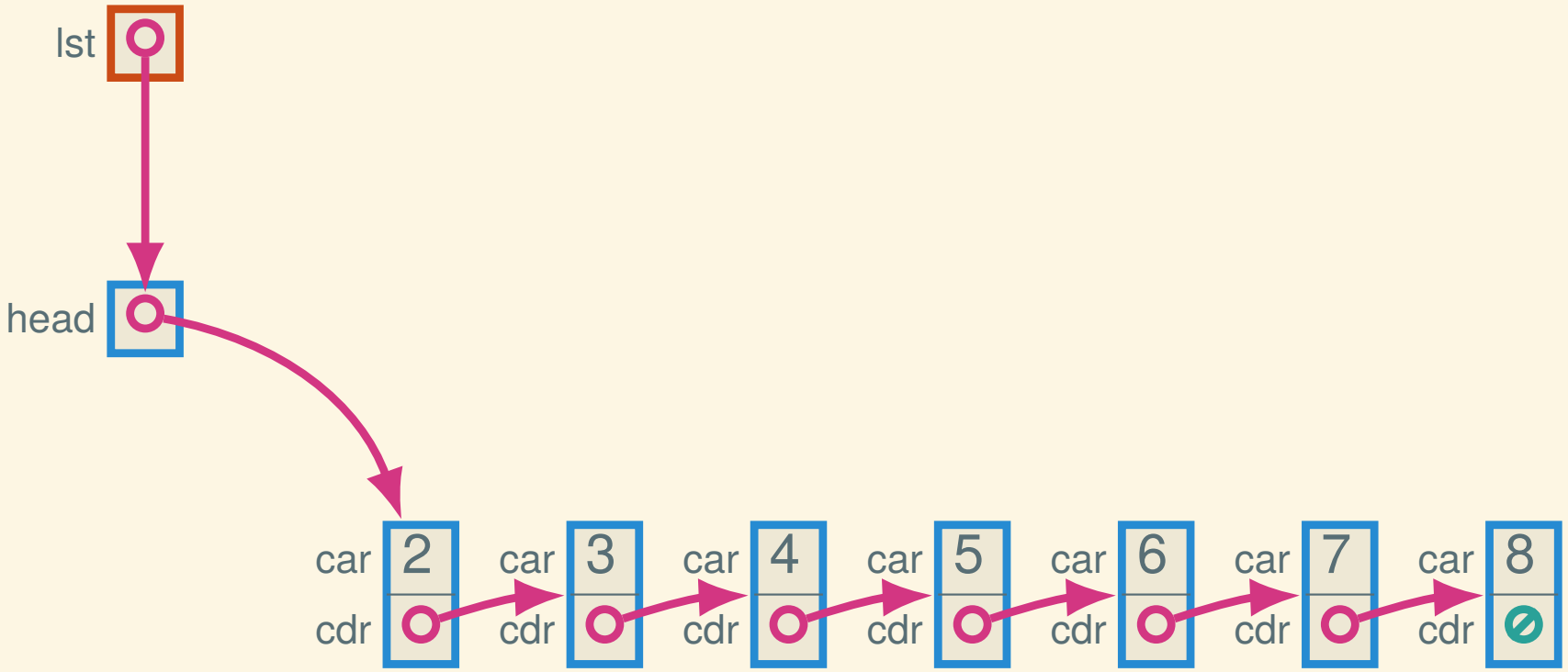


Indirection



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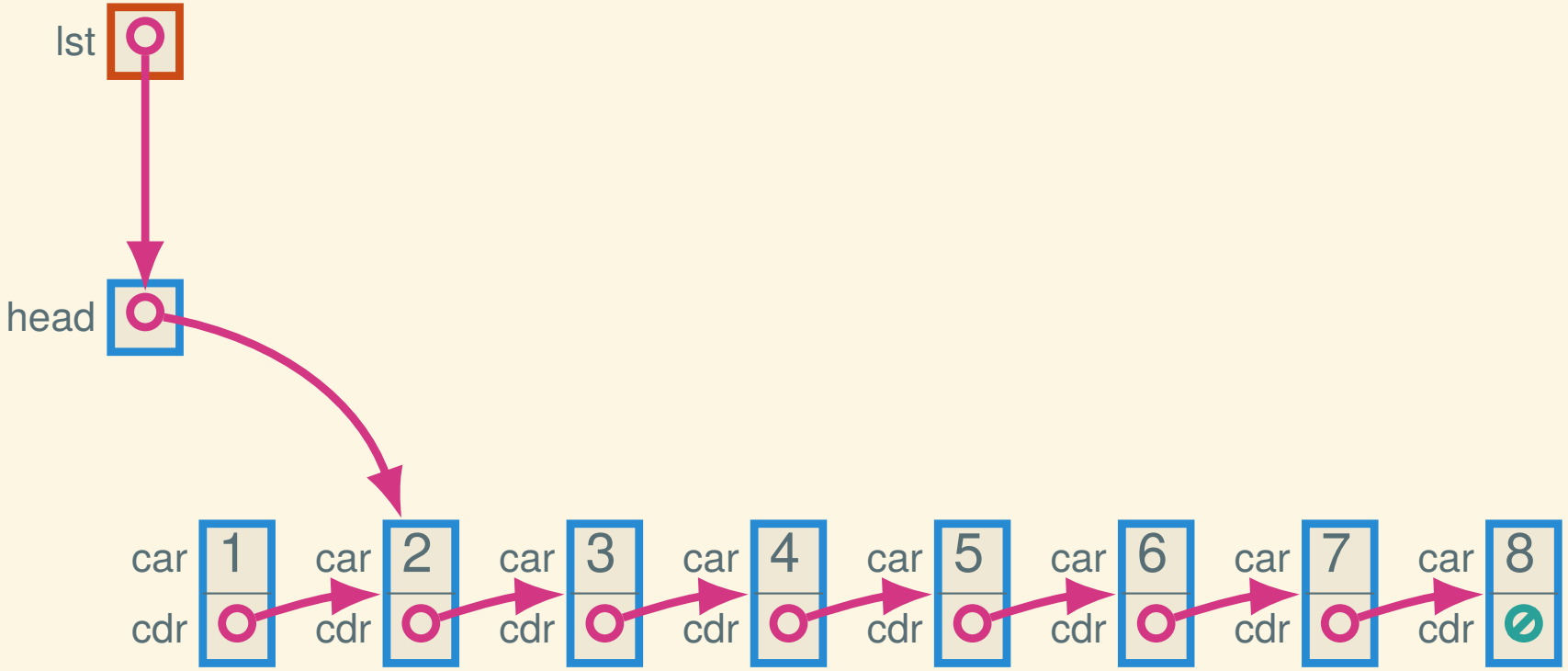

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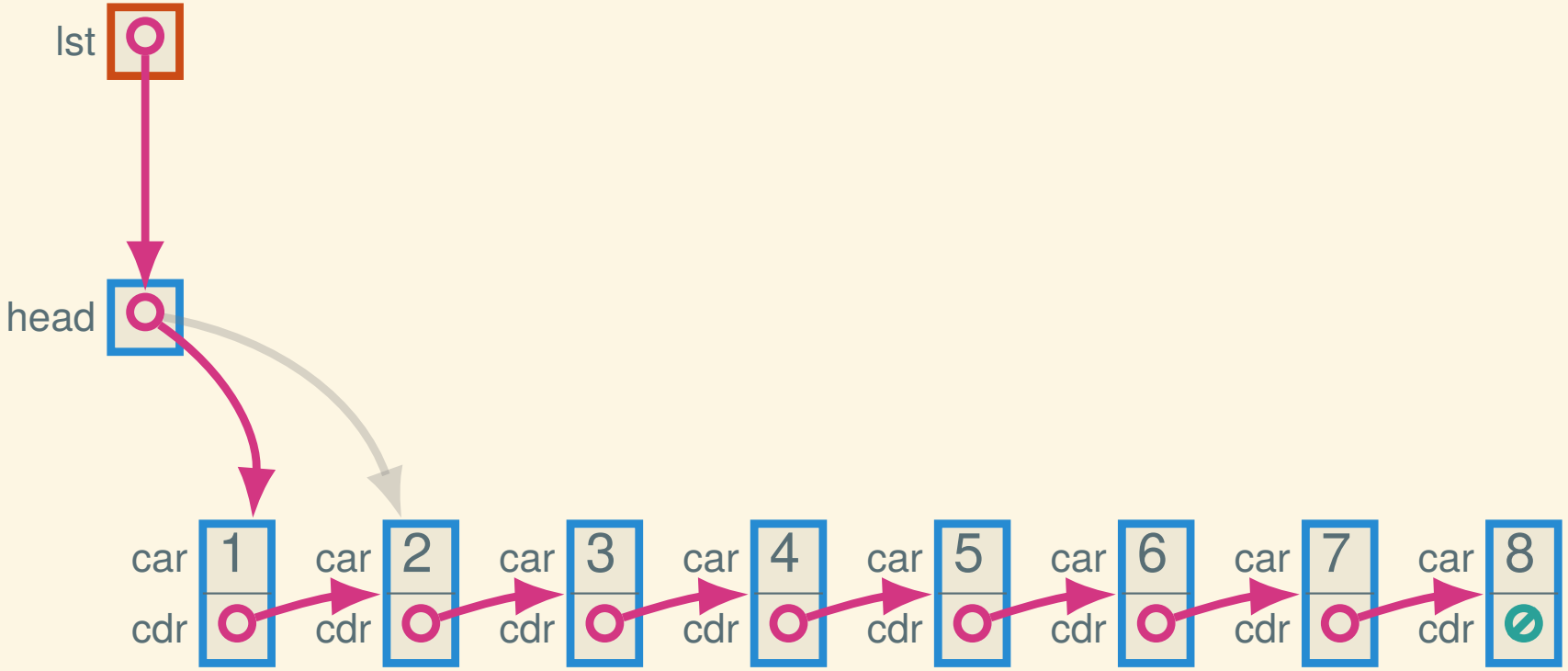

Now in DSSL2

Linked lists in DSSL2

```
# Link is one of:
# - node { data: Number, next: Link }
# - None
struct node:
    let data
    let next

class SLL:
    let head

    def __init__(self):
        self.head = None
```

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# Link is one of:
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struct node:
    let data
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class SLL:
    let head

    def __init__(self):
        self.head = None

    def push_front(self, data):
        self.head = node(data, self.head)
```

List operations in DSSL2

```
class SLL:
    …

    def get_front(self):
        if node?(self.head): self.head.data
        else: error('SLL.get_front: empty list')
```

List operations in DSSL2

```
class SLL:
    …

    def get_front(self):
        if node?(self.head): self.head.data
        else: error('SLL.get_front: empty list')

    def get_nth(self, n):
        let curr = self.head
        while n > 0:
            if curr is None:
                error('SLL.get_nth: too short')
            curr = curr.next
            n = n - 1
        curr.data
```

More DSSL2 list operations

A (re)factoring:

```
class SLL:
    …

    def _find_nth_node(self, n):
        let curr = self.head
        while n > 0:
            if curr is None: error('too short')
            curr = curr.next
            n = n - 1
        curr

    def get_nth(self, n):
        self._find_nth_node(n).data

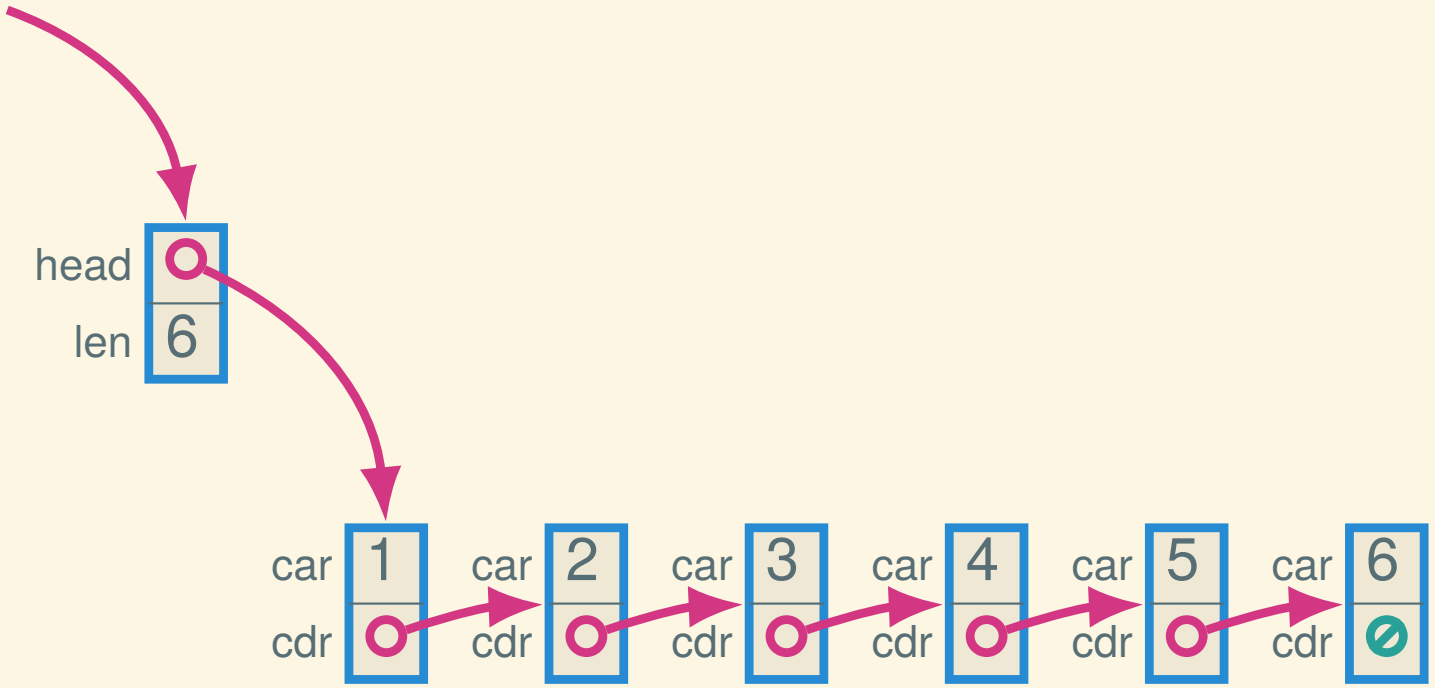
    def set_nth(self, n, val):
        self._find_nth_node(n).data = val
```

What else might we want to do?

What else might we want to do?

- Insert or remove at the given position or the end.
- Split a list in two or splice two into one.
- Know how long the list is without counting.

Keeping the length



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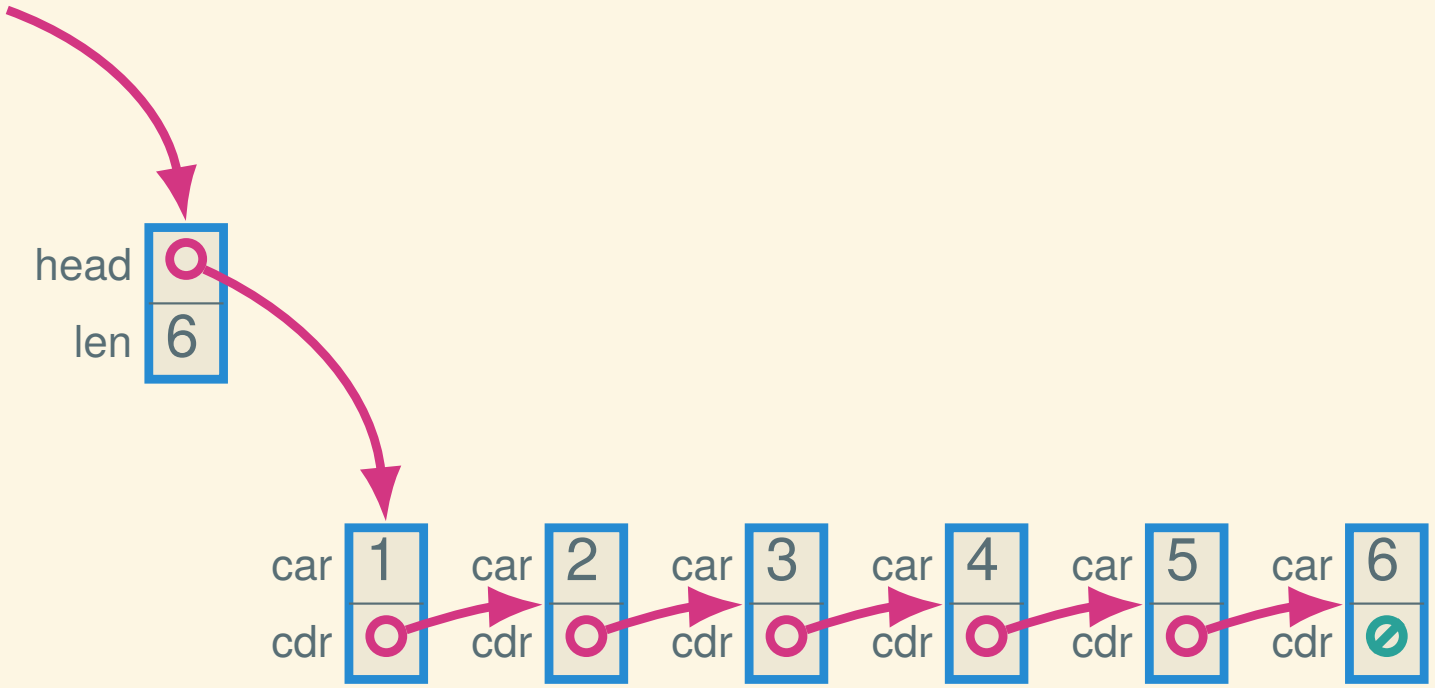
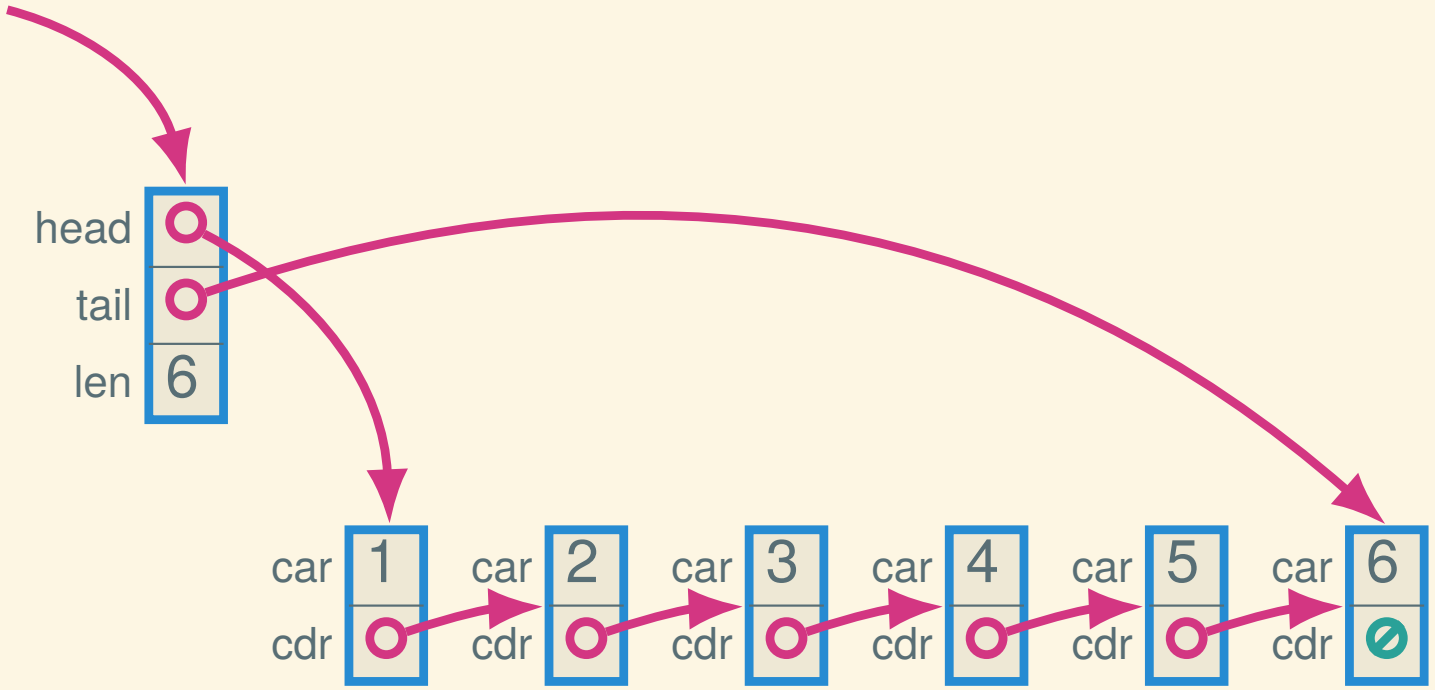


How can we make sure the `len` field is always right?

Quick access to the tail



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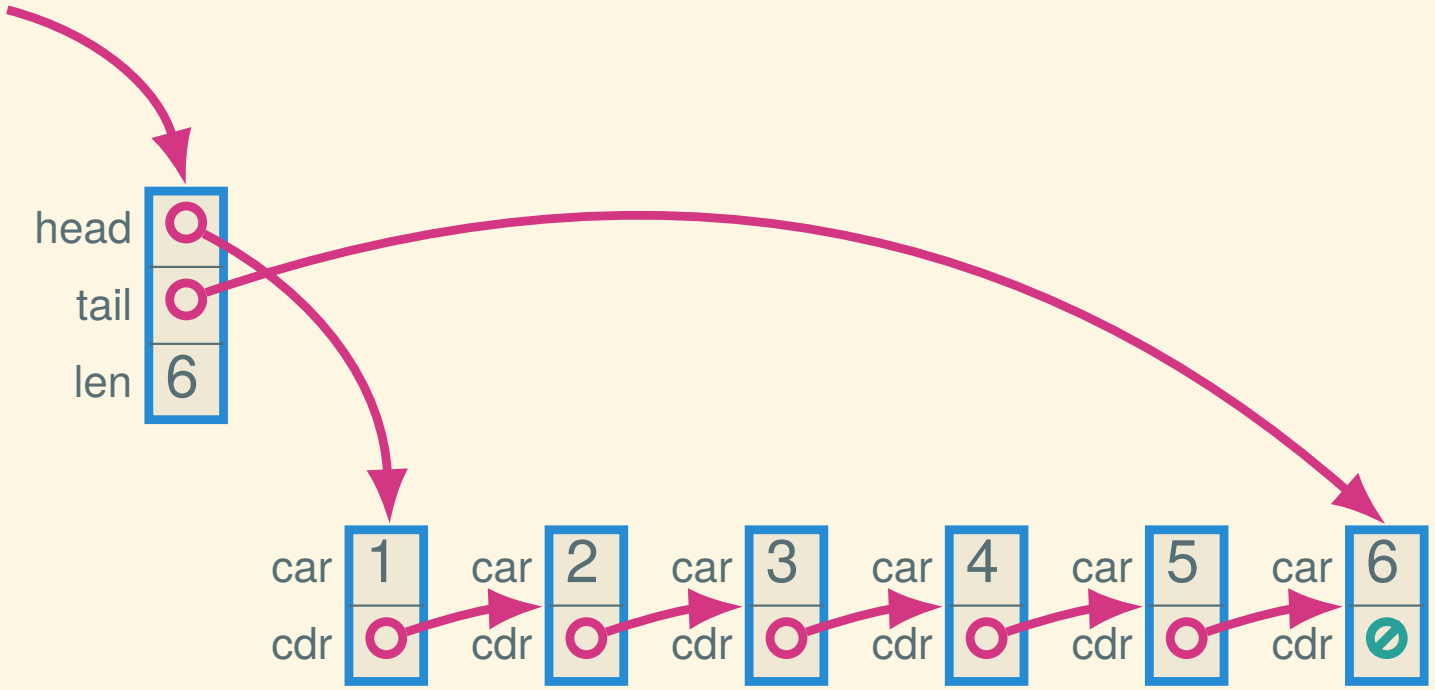
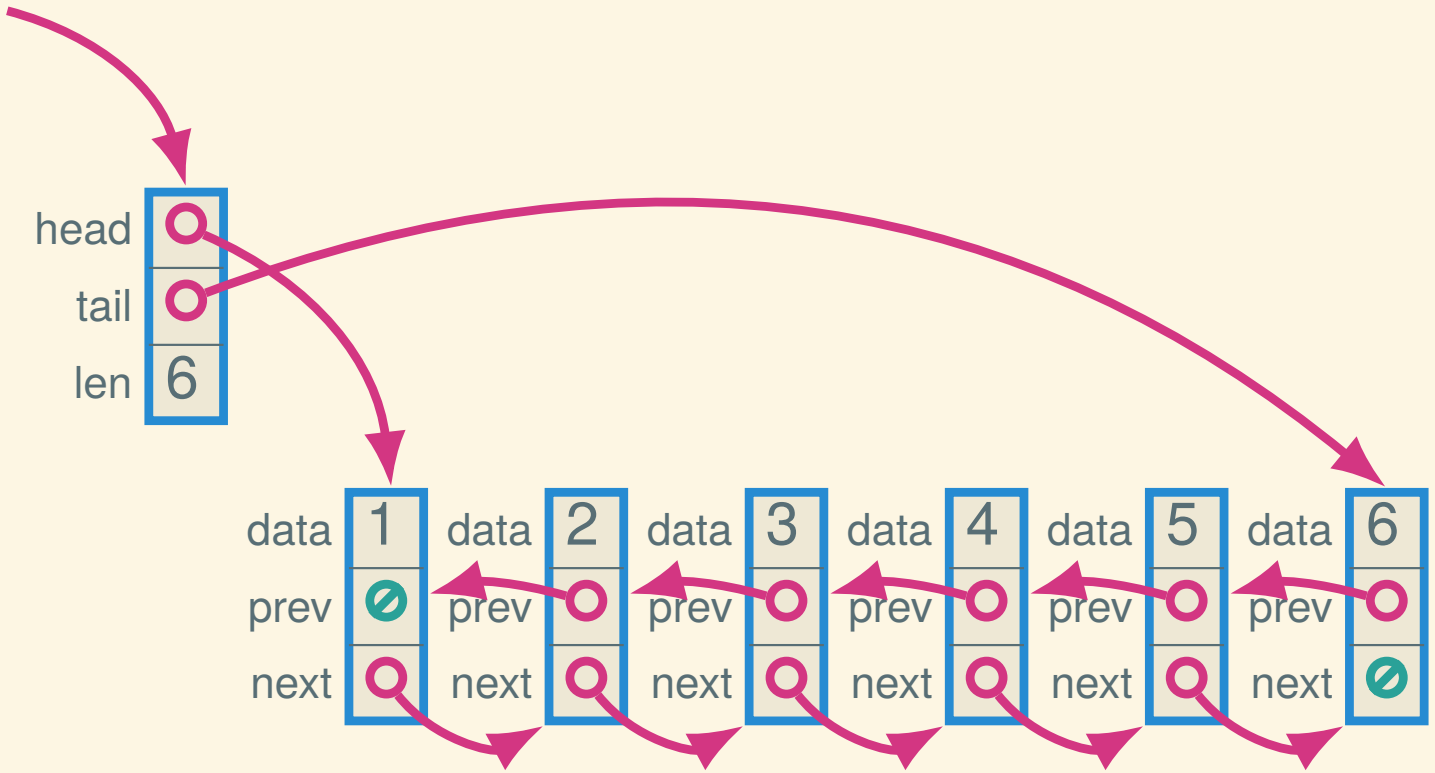
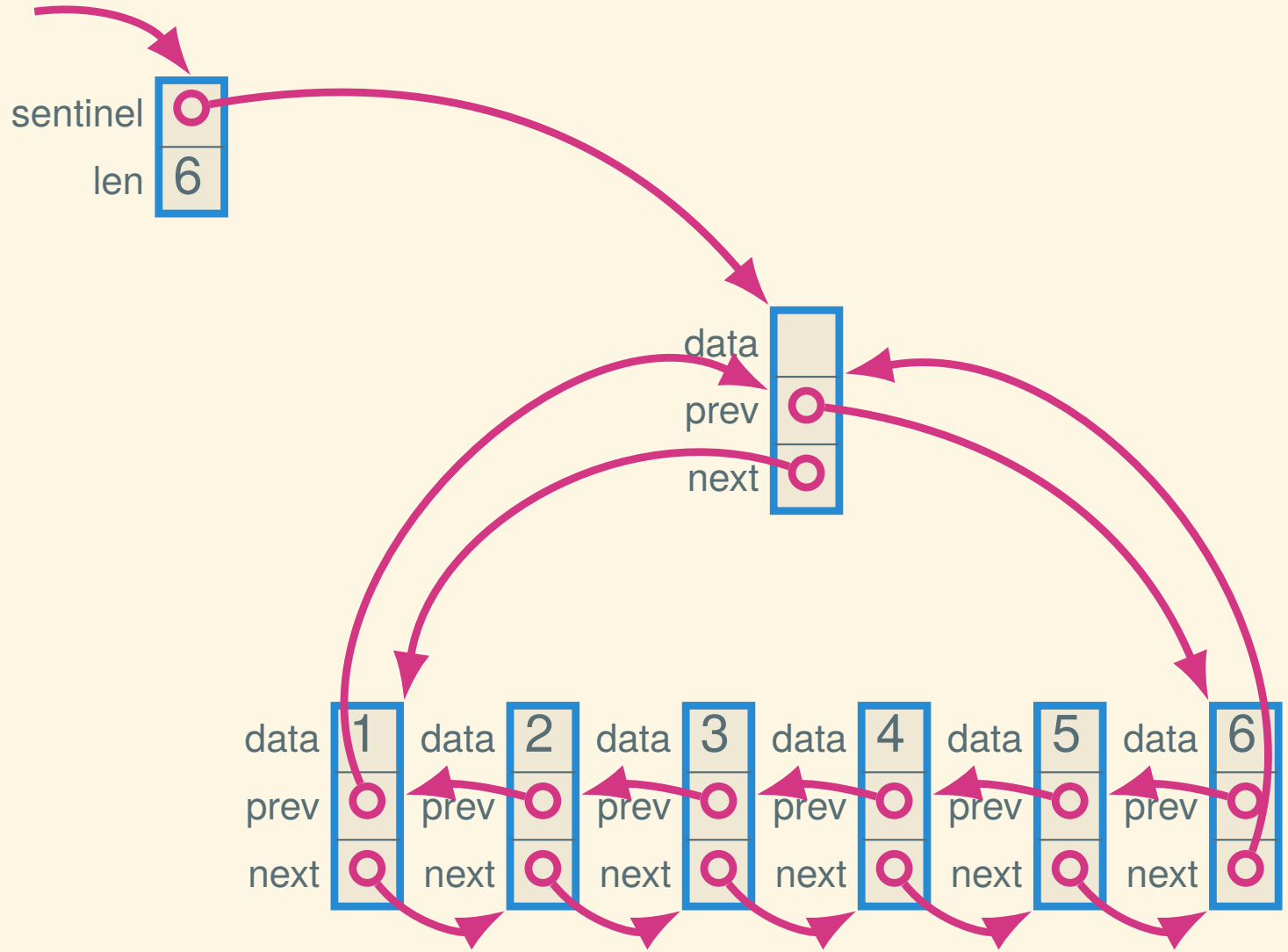


Which operations are simple now? Which are still more work?

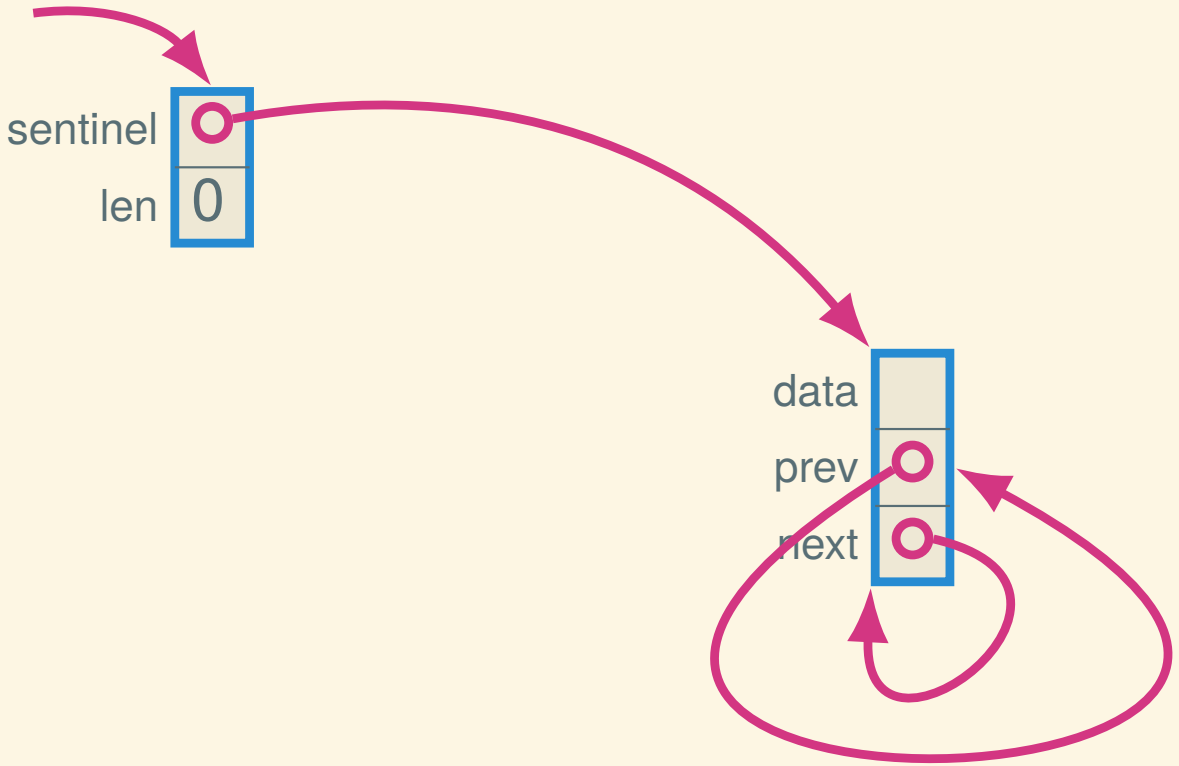
Doubly-linked



Circular, doubly-linked with sentinel



Empty (circular, doubly-linked w/sentinel)



Codewalk

Let's look at a singly-linked list class in DSSL2.

Next time: abstract data types