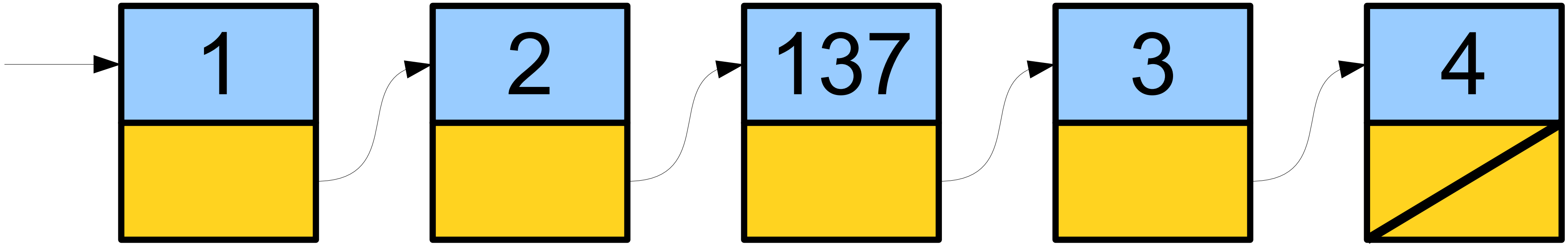
Linked Lists

Part Two

Recap from Last Time

Linked Lists at a Glance

- A ***linked list*** is a data structure for storing a sequence of elements.
- Each element is stored separately from the rest.
- The elements are then chained together into a sequence.



Representing a Cell

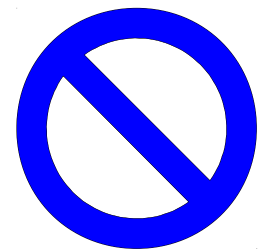
- For simplicity, let's assume we're building a linked list of `string`s.
- We can represent a cell in the linked list as a structure:

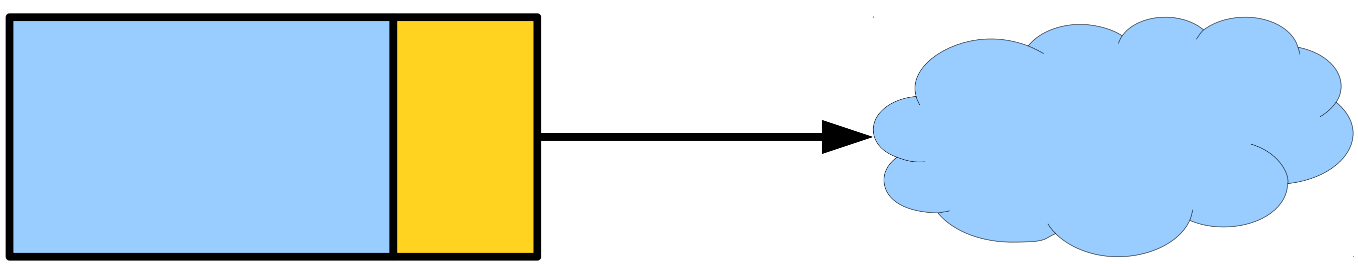
```
struct Cell {
    string value;
    Cell* next;
};
```

- ***The structure is defined recursively!***

A Linked List is Either…

…an empty list, represented by **nullptr**, or…





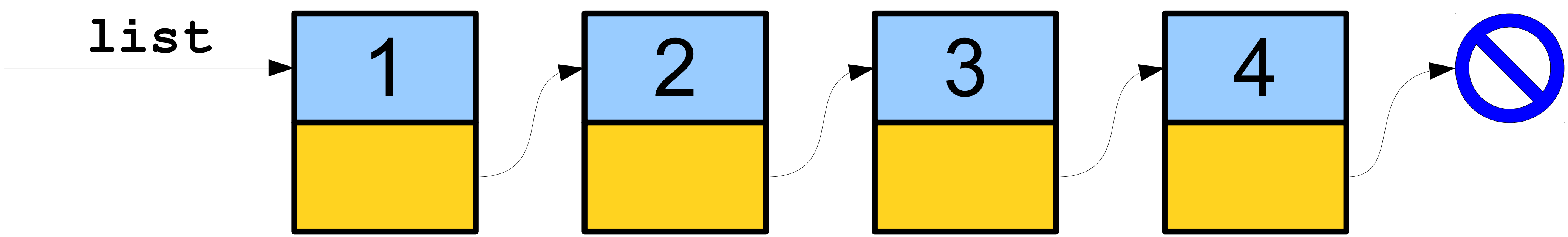
a single linked list cell that points…

… at another linked list.

Traversing a Linked List

- Once we have a linked list, we can traverse it by following the links one at a time.

```
for (Cell* ptr = list; ptr != nullptr; ptr = ptr->next) {
    /* … use ptr … */
}
```



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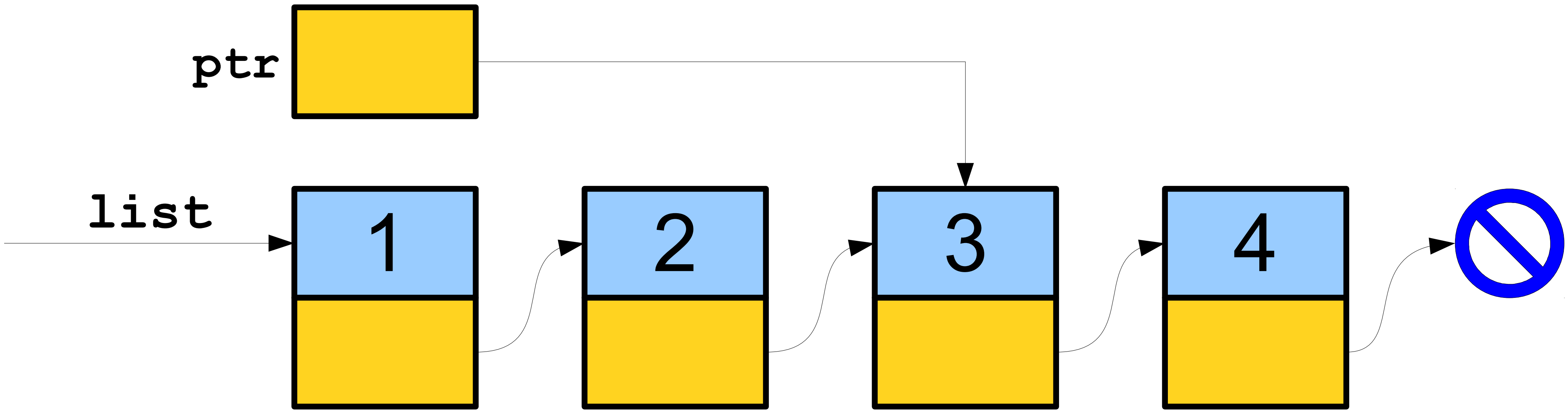

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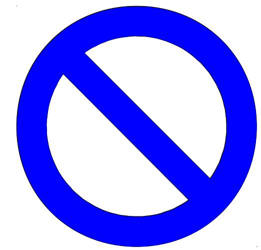

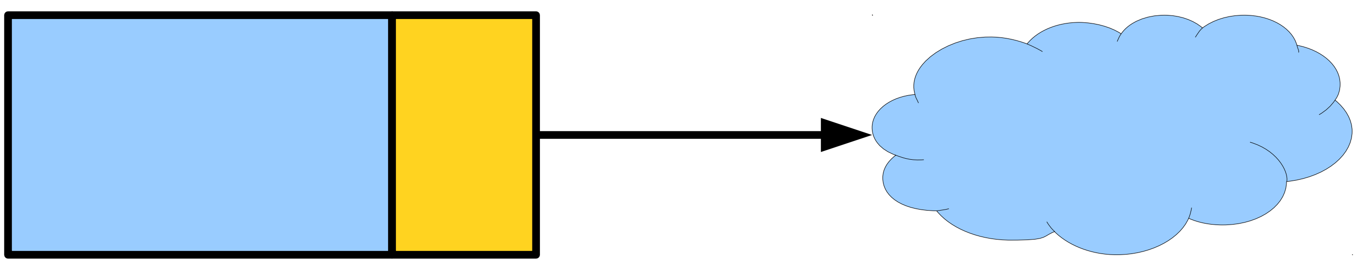

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New Stuff!

Cleaning Up Our Messes

Freeing a Linked List

- All good things must come to an end, and we eventually need to reclaim the memory for a linked list.
- The following code triggers *undefined behavior*. ***Don't do this!***

```
for (Cell* ptr = list; ptr != nullptr; ptr = ptr->next) {
    delete ptr;
}
```

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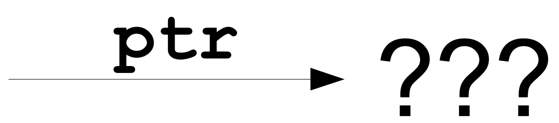

Freeing a Linked List Properly

- To properly free a linked list, we have to be able to
  - Destroy a cell, and
  - Advance to the cell after it.
- How might we accomplish this?

```
while (list != nullptr) {
   Cell* next = list->next;
   delete list;
   list = next;
}
```

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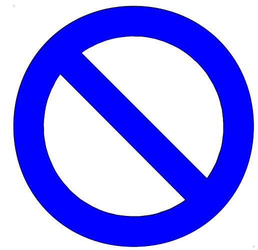

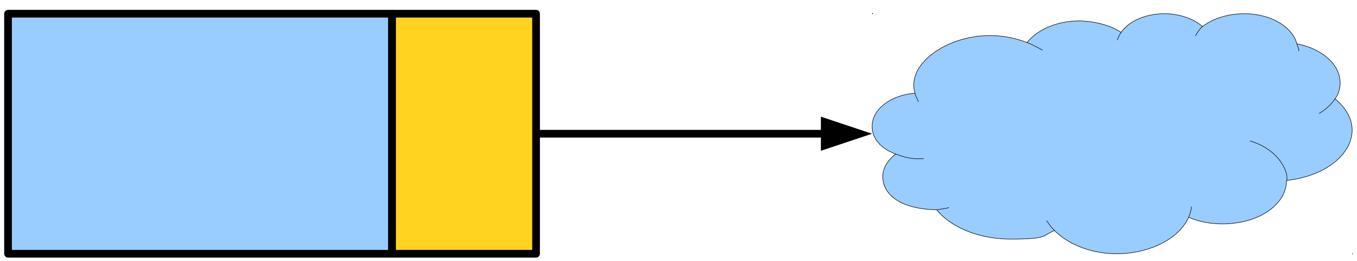

a single linked list cell that points…

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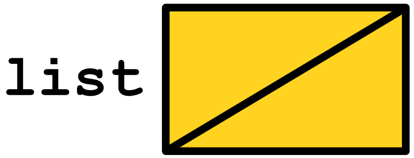
Linked Lists: The Tricky Parts

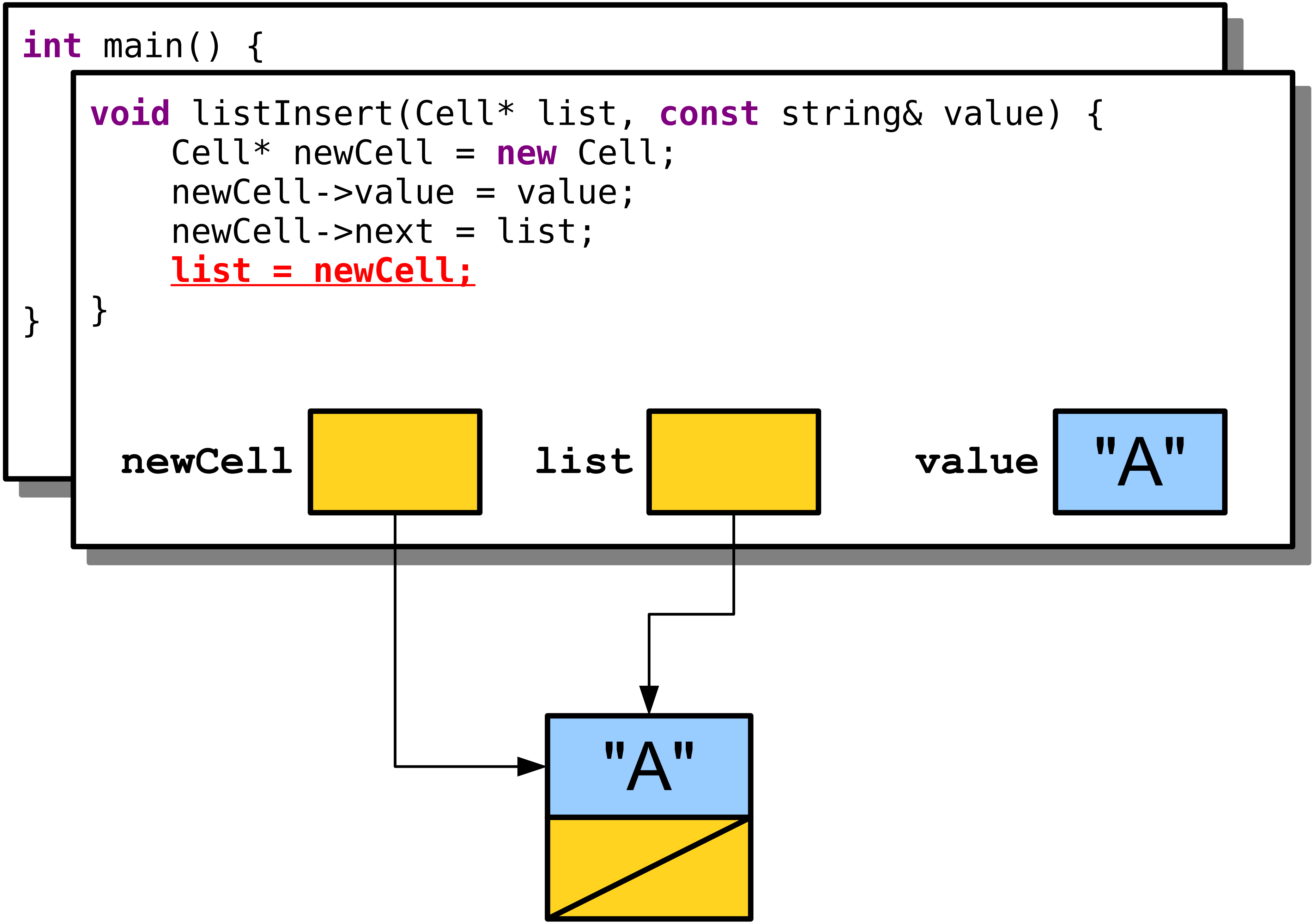
- Suppose that we want to write a function that will add an element to the front of a linked list.
- What might this function look like?

What went wrong?

```
int main() {
    Cell* list = nullptr;
    listInsert(list, "A");
    listInsert(list, "B");
    listInsert(list, "C");

    return 0;
}
```




int main() {
}
void listInsert(Cell* list, const string& value) {
Cell* newCell = new Cell;
newCell->value = value;
newCell->next = list;
list = newCell;
}
newCell
list
value
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"A"

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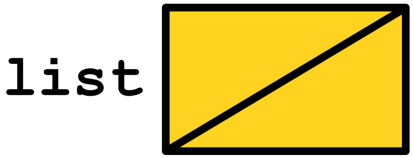

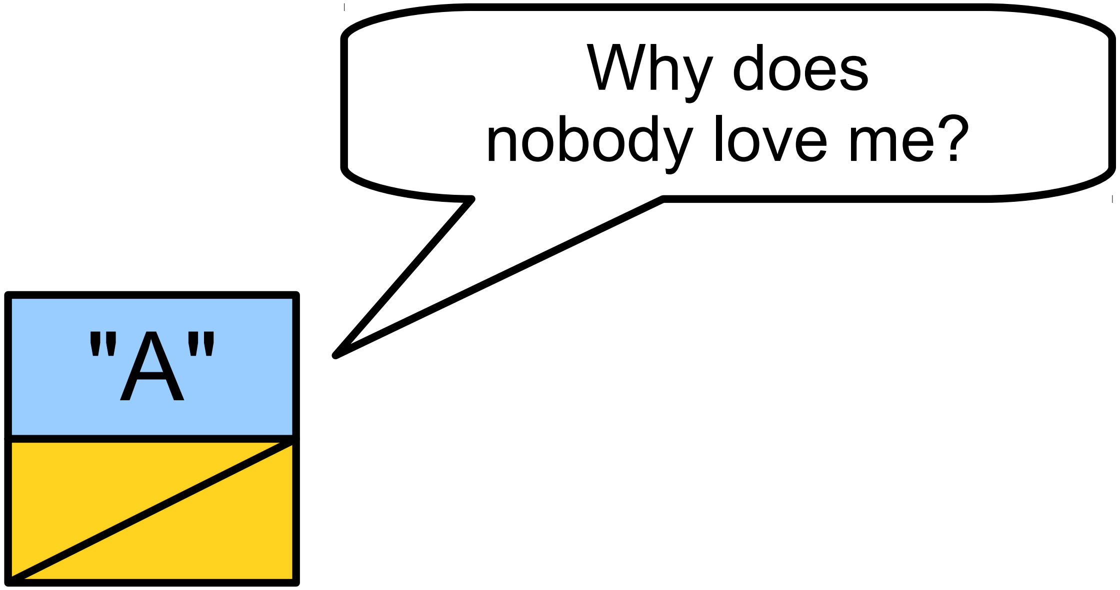

Pointers by Reference

- To resolve this problem, we can pass the linked list pointer by reference.
- Our new function:

```
void listInsert(Cell*& list, const string& value) {
    Cell* newCell = new Cell;
    newCell->value = value;
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void listInsert(Cell*& list, const string& value) {
    Cell* newCell = new Cell;
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}
```

This is a reference to a pointer to a Cell. If we change where list points in this function, the changes will stick!

```
int main() {
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    return 0;
}
```
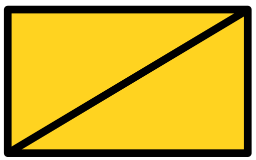
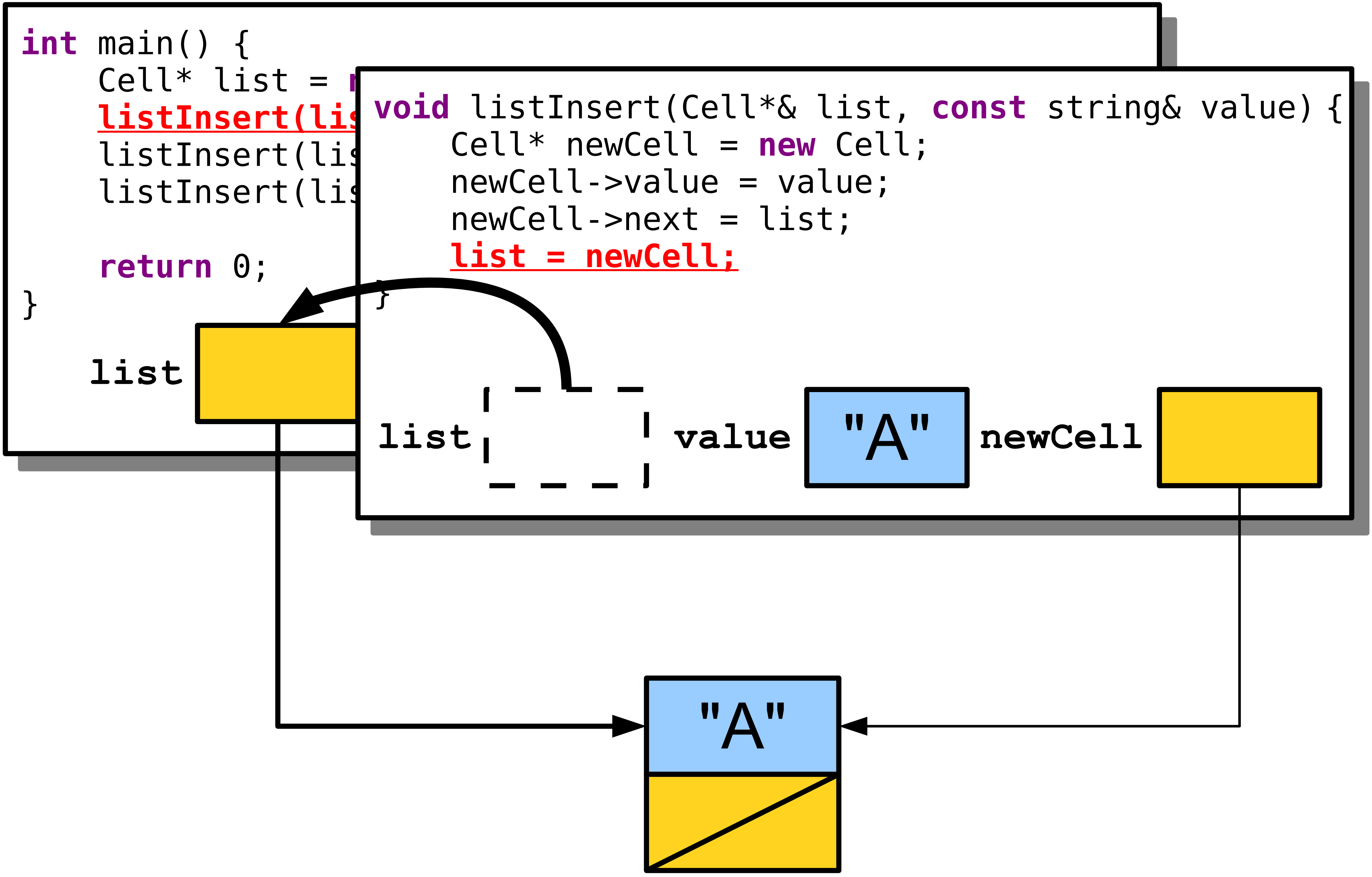

list 



int main() {
Cell* list =
listInsert(li
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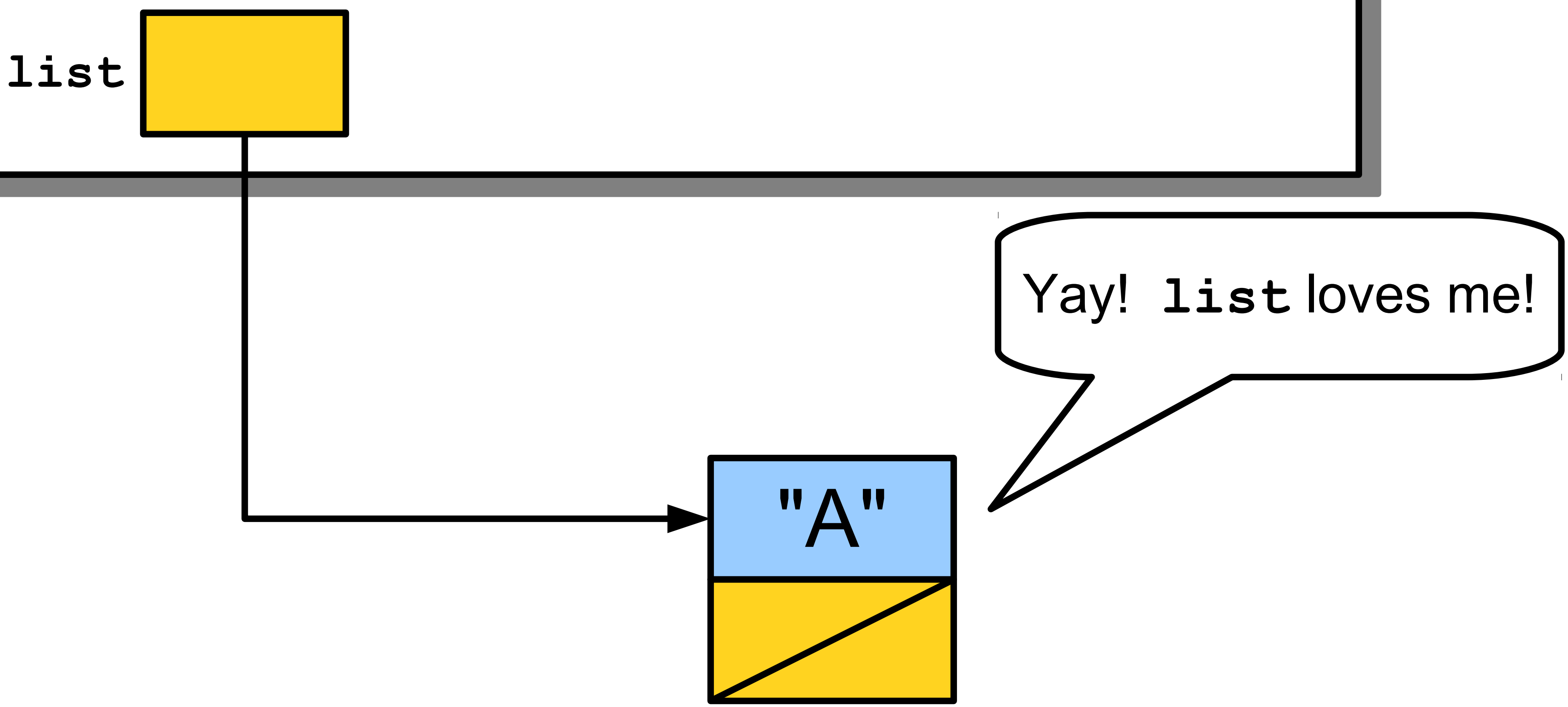

Pointers by Reference

- If you pass a pointer into a function *by value*, you can change the contents at the object you point at, but not *which* object you point at.
- If you pass a pointer into a function *by reference*, you can *also* change *which* object is pointed at.

Time-Out for Announcements!

Assignment 5

- Assignment 5 (***Priority Queue***) goes out today. It's due next Friday at the start of class.
- It's a four-parter, and we've included a timetable on the front of the assignment.
    - ***Start this assignment as soon as you get it!*** You'll have plenty of time to finish everything, but not if you put it off to the last minute.
- Working in pairs is permitted – and encouraged! – on this assignment.
- Anton will be holding YEAH hours tomorrow evening. We'll announce the time and location on Piazza and over email.

Stanford Women
in Computer Science

CASUAL CS DINNER

{w}

Monday, February 27 from 6-7 PM at the WCC
RSVP link **here!**

Come have dinner with CS students and faculty. Everyone is welcome, especially students just starting out in CS!

Midterm Timetable

- You’re done with the midterm exam! Woohoo!
- We’ll be grading it over the weekend and returning graded exams on Monday along with stats and solutions.
- Have any questions in the meantime? Just ask!

Back to Linked Lists!

Tail Pointers

- A ***tail pointer*** is a pointer to the last element of a linked list.
- Tail pointers make it easy and efficient to add new elements to the back of a linked list.
- We can use tail pointers to implement an efficient `Queue` using a linked list.

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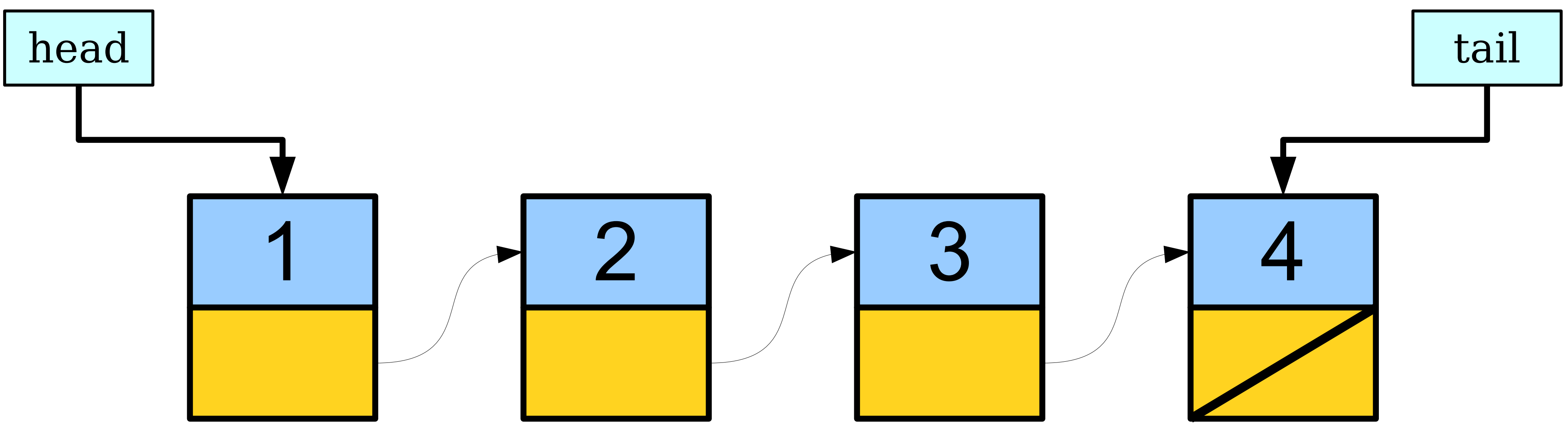
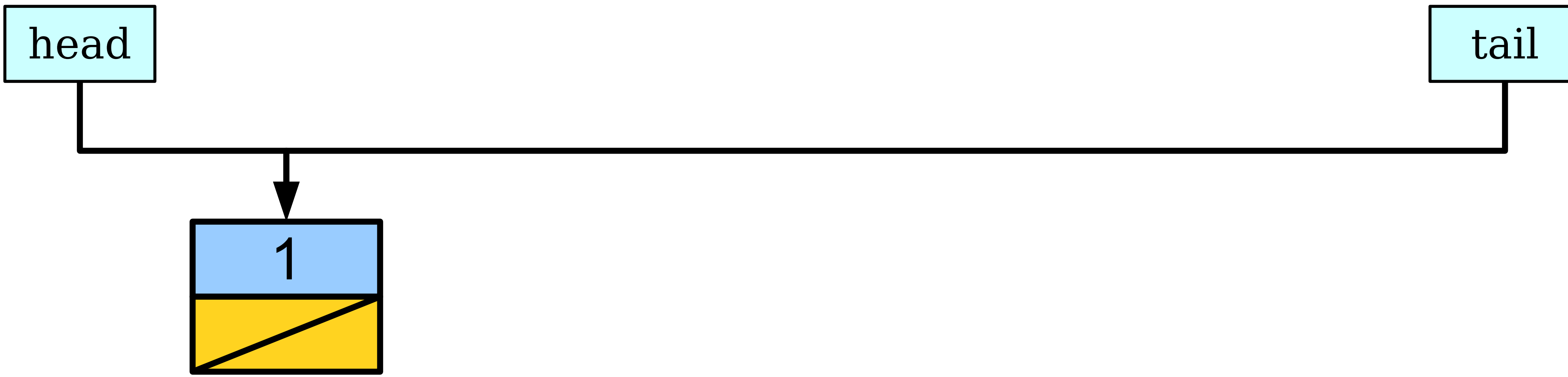
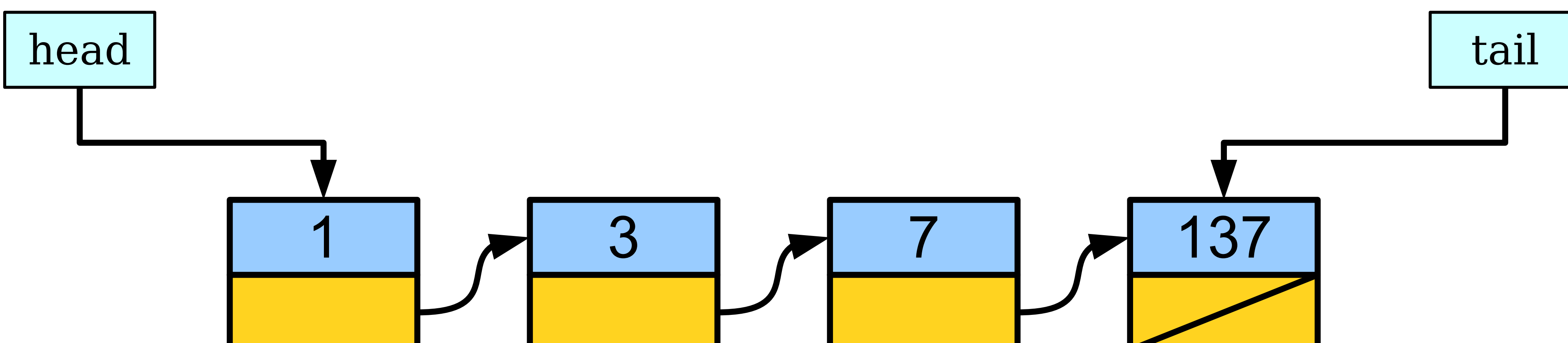


Enqueuing Things

- ***Case 1:*** The queue is empty.

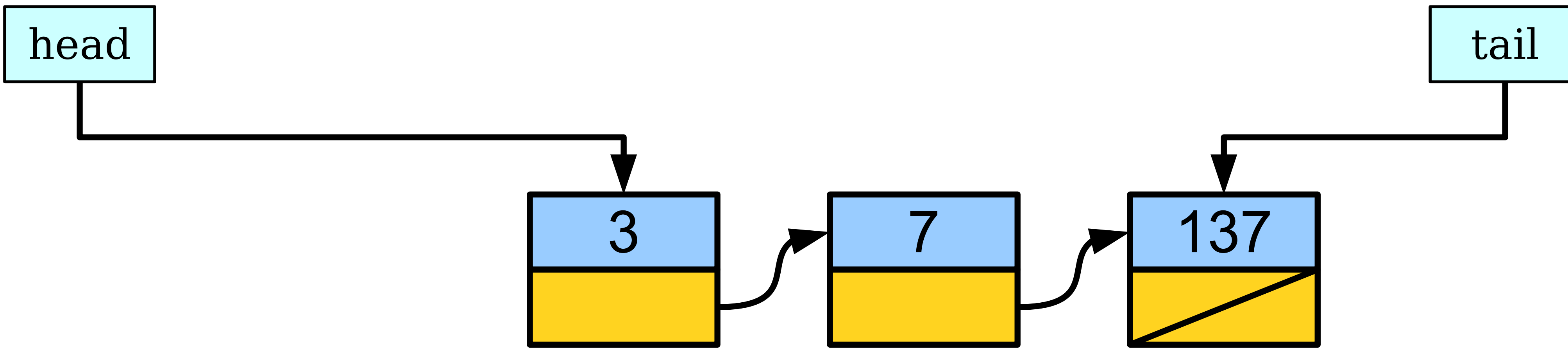


- ***Case 2:*** The queue is not empty.



Dequeuing Things

- ***Case 1:*** Dequeuing when there are 2+ elements.



- ***Case 2:*** Dequeuing the last element.

Analyzing Efficiency

- What is the big-O complexity of a dequeue?
- Answer: **O(1)**.
- What is the big-O complexity of an enqueue?
- Answer: **O(1)**.