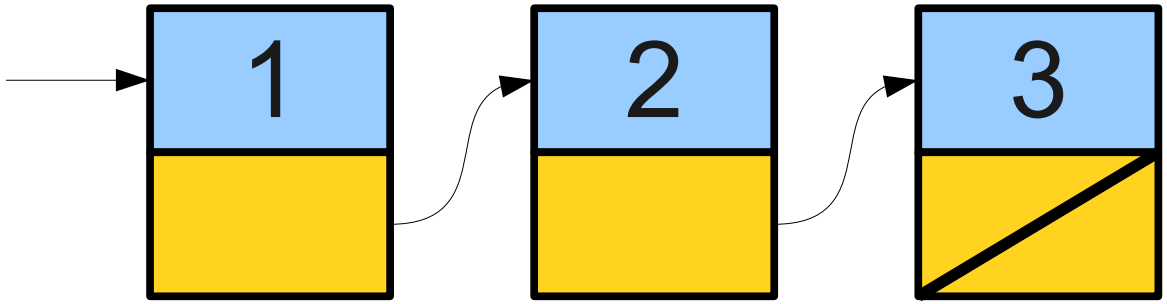
Linked Lists

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.



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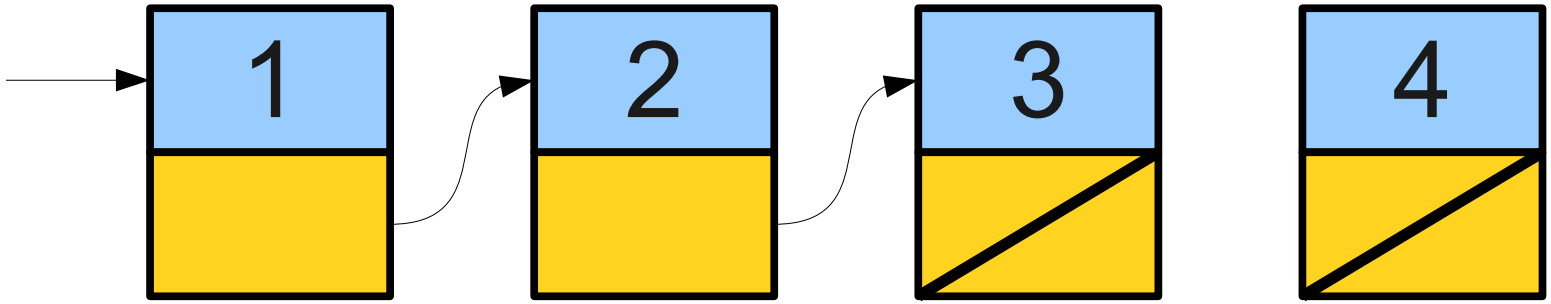

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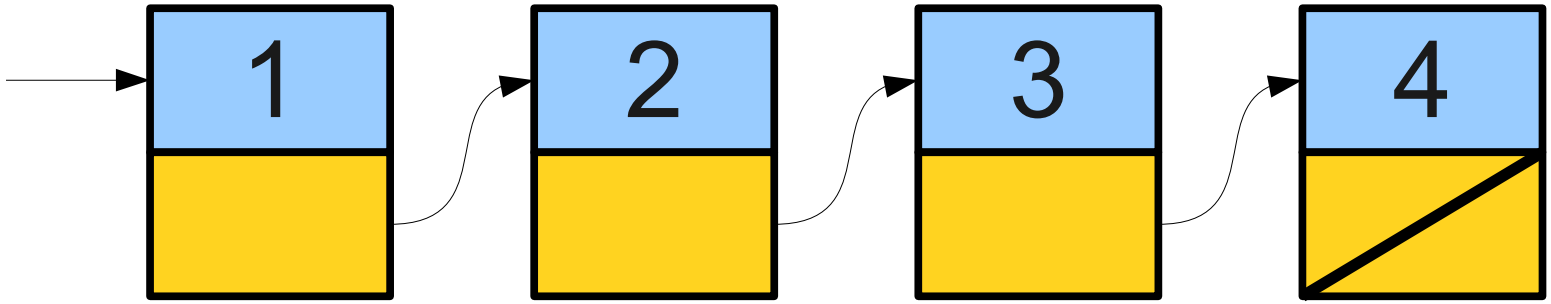

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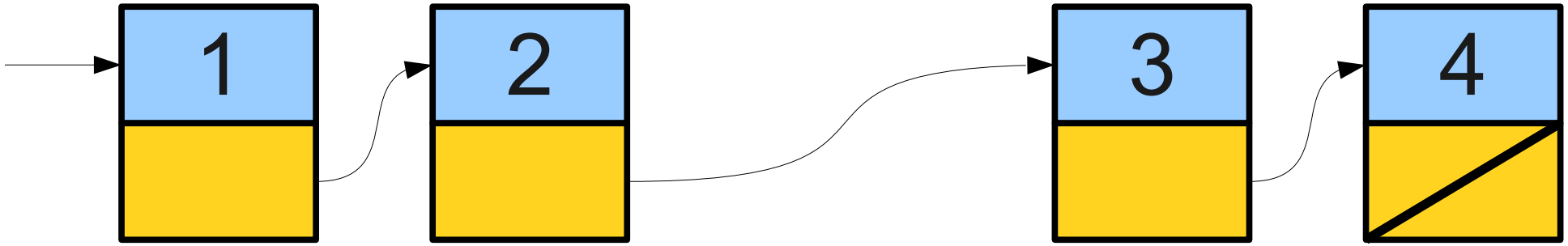

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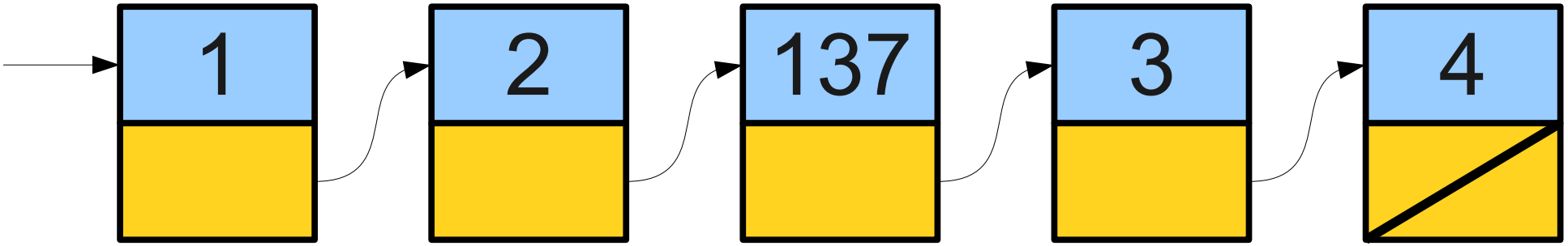

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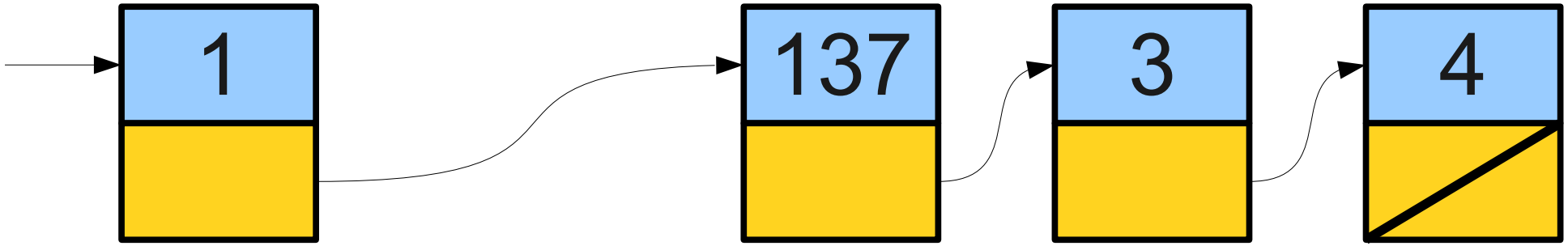

Linked List Cells

- A linked list is a chain of **cells**.
- Each cell contains two pieces of information:
  - Some piece of data that is stored in the sequence, and
  - A **link** to the next cell in the list.
- We can traverse the list by starting at the first cell and repeatedly following its link.

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 {
    Type value;
    Cell* next;
};
```

- **The structure is defined recursively!**

Building a Linked List

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while (true) {
   string line = getLine("Next entry? ");
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   cell->value = line;

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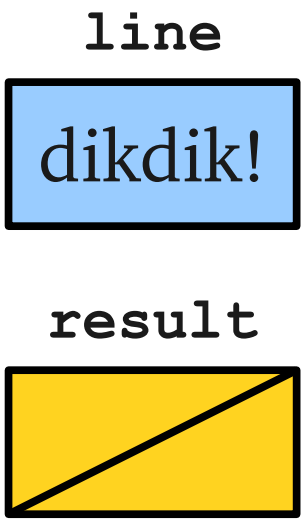

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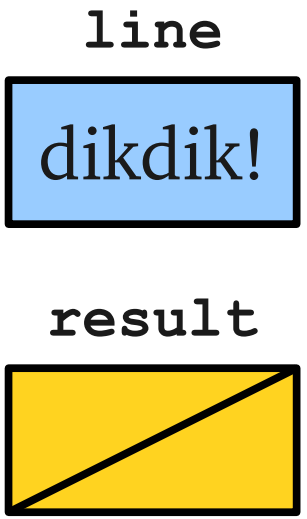

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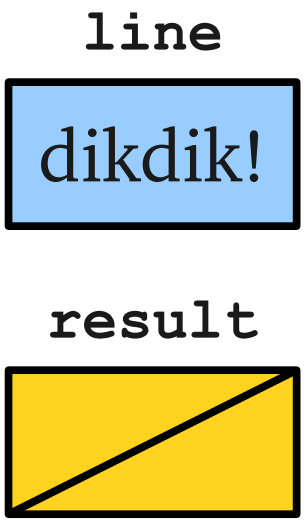

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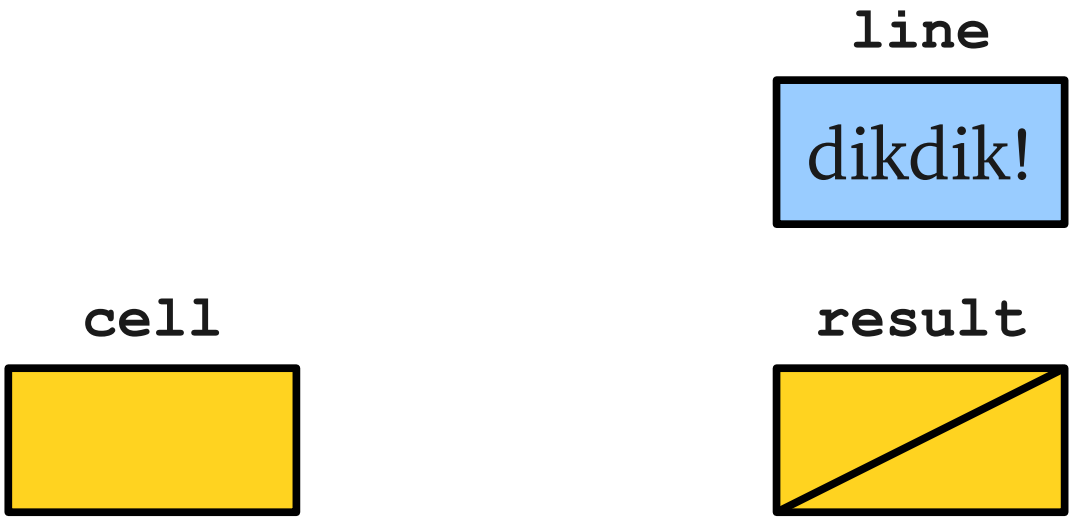

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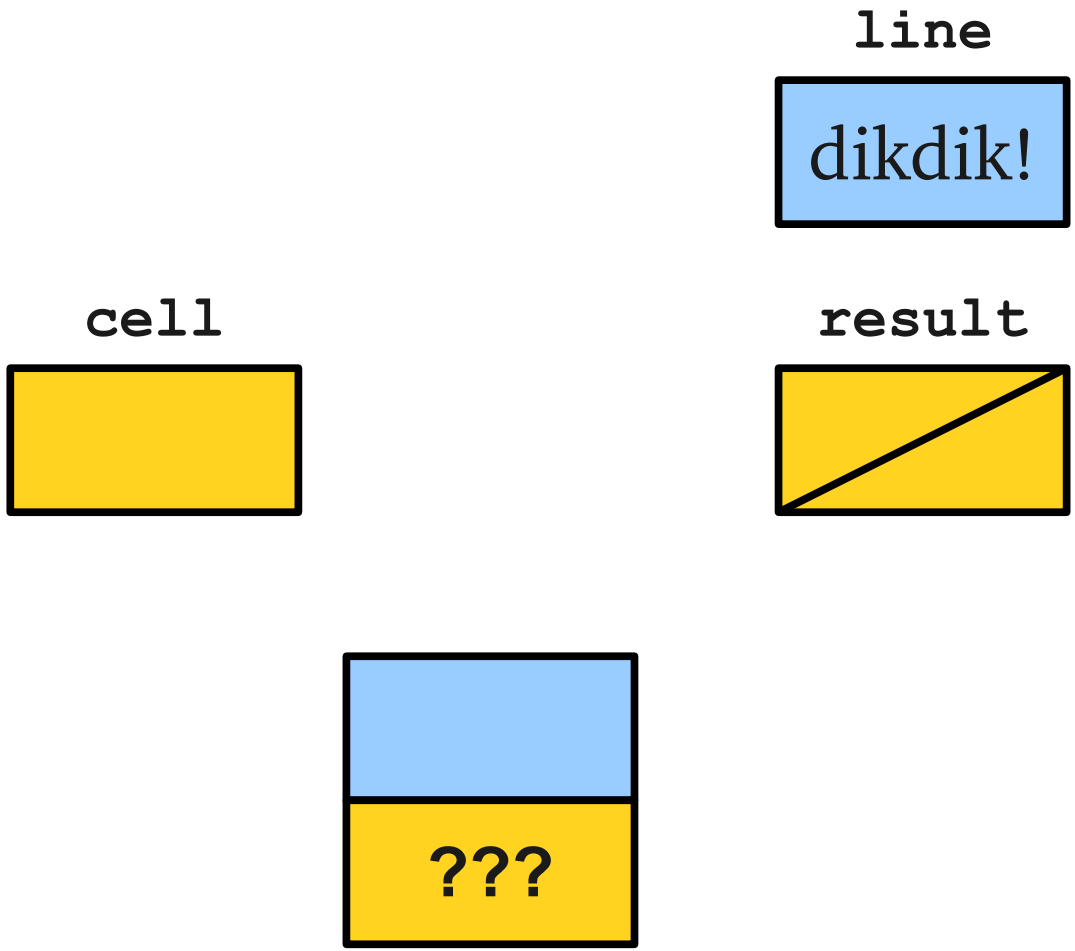

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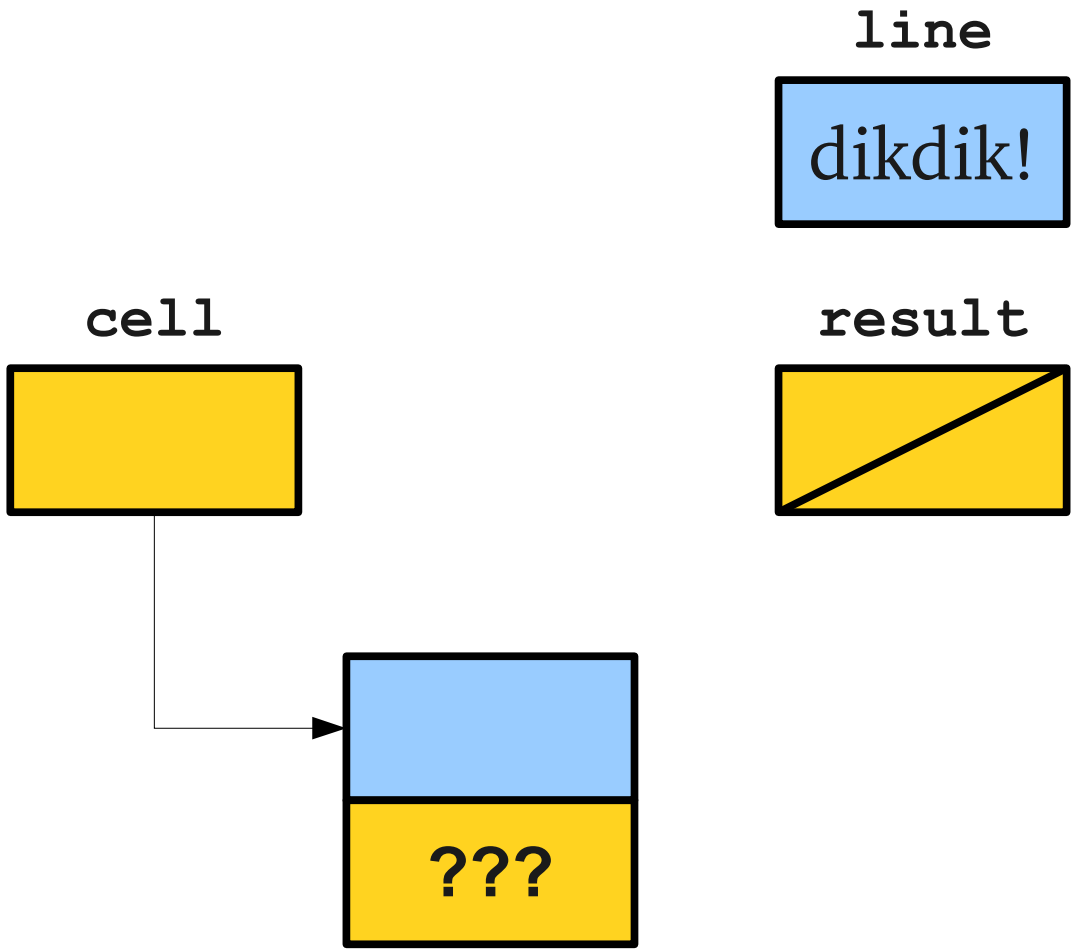

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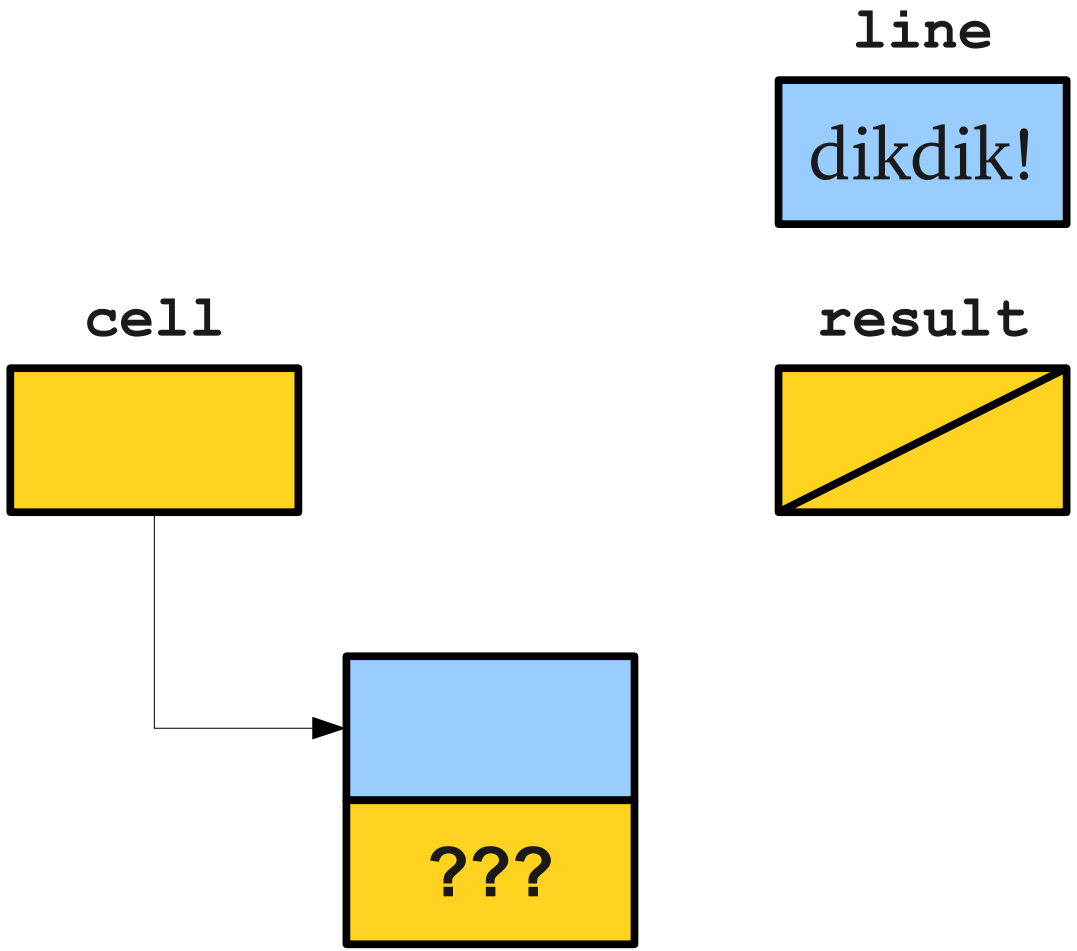

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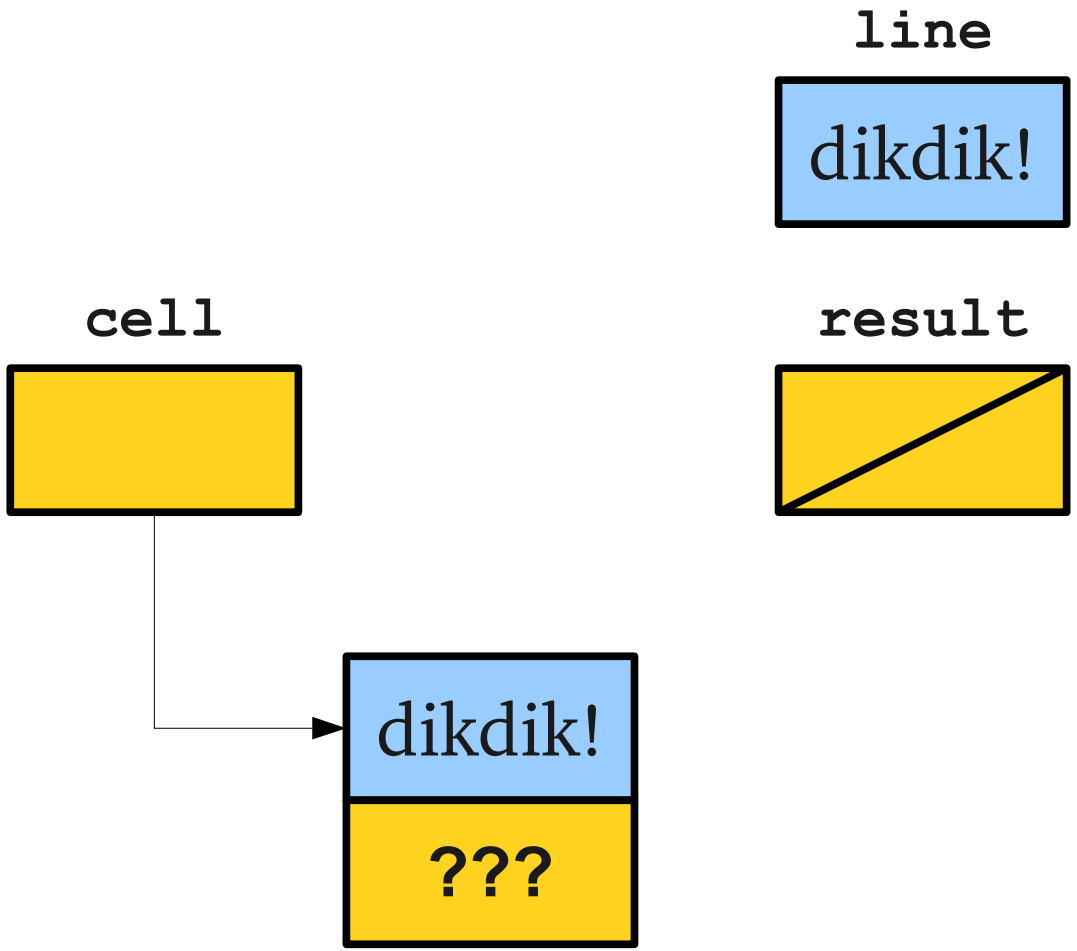

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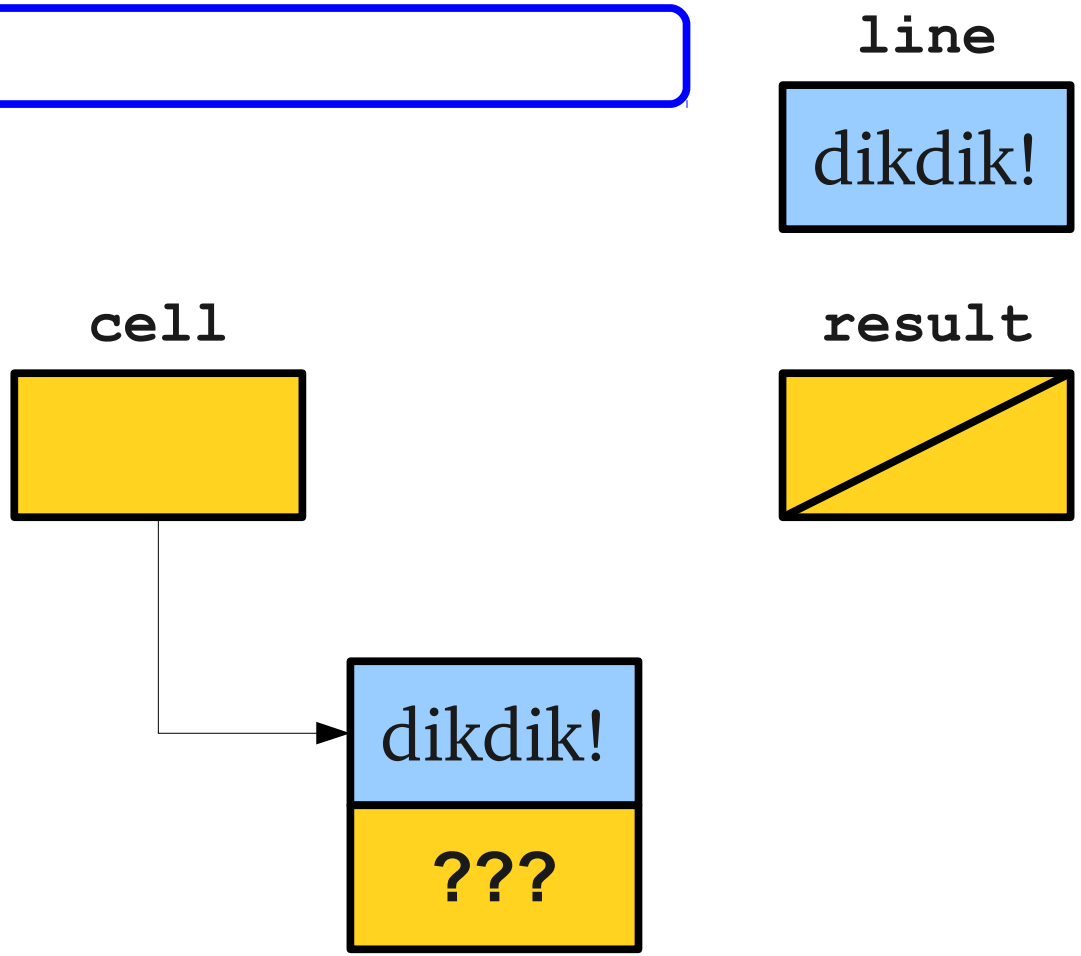

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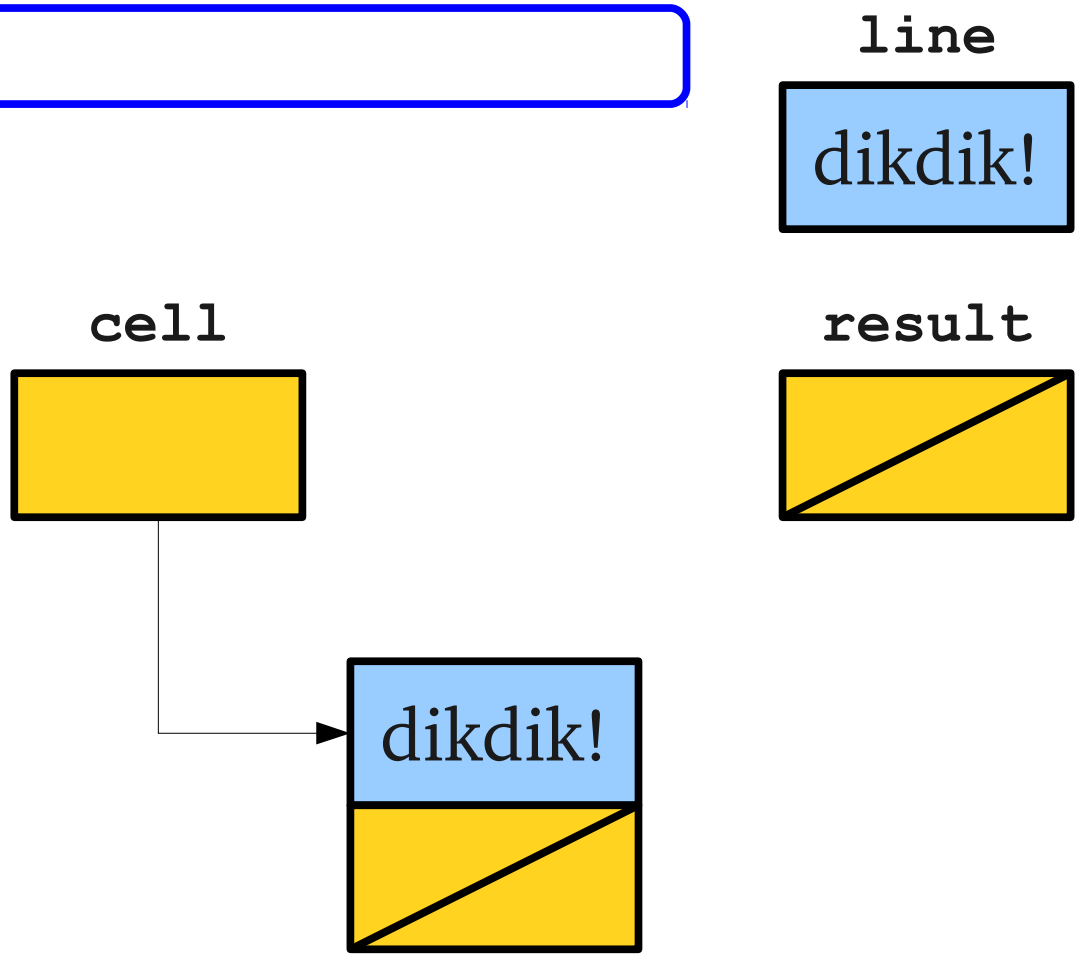

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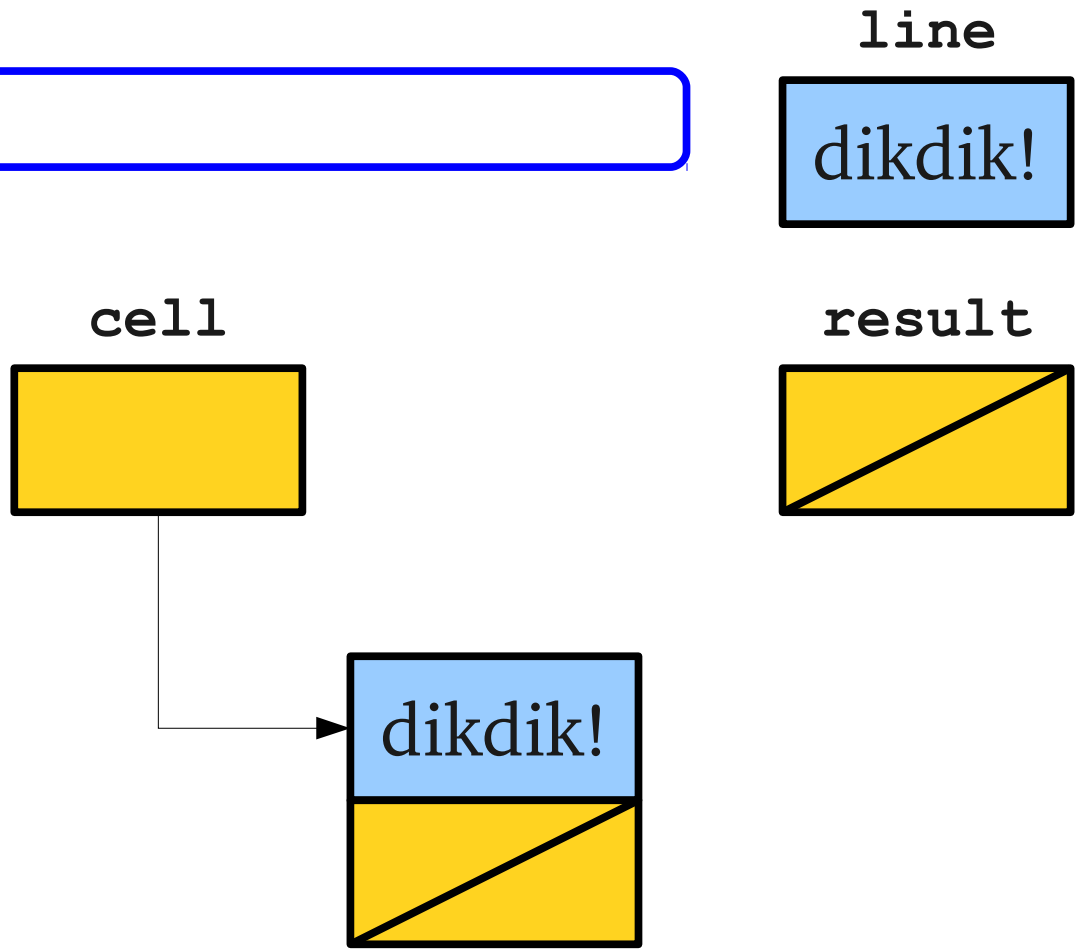

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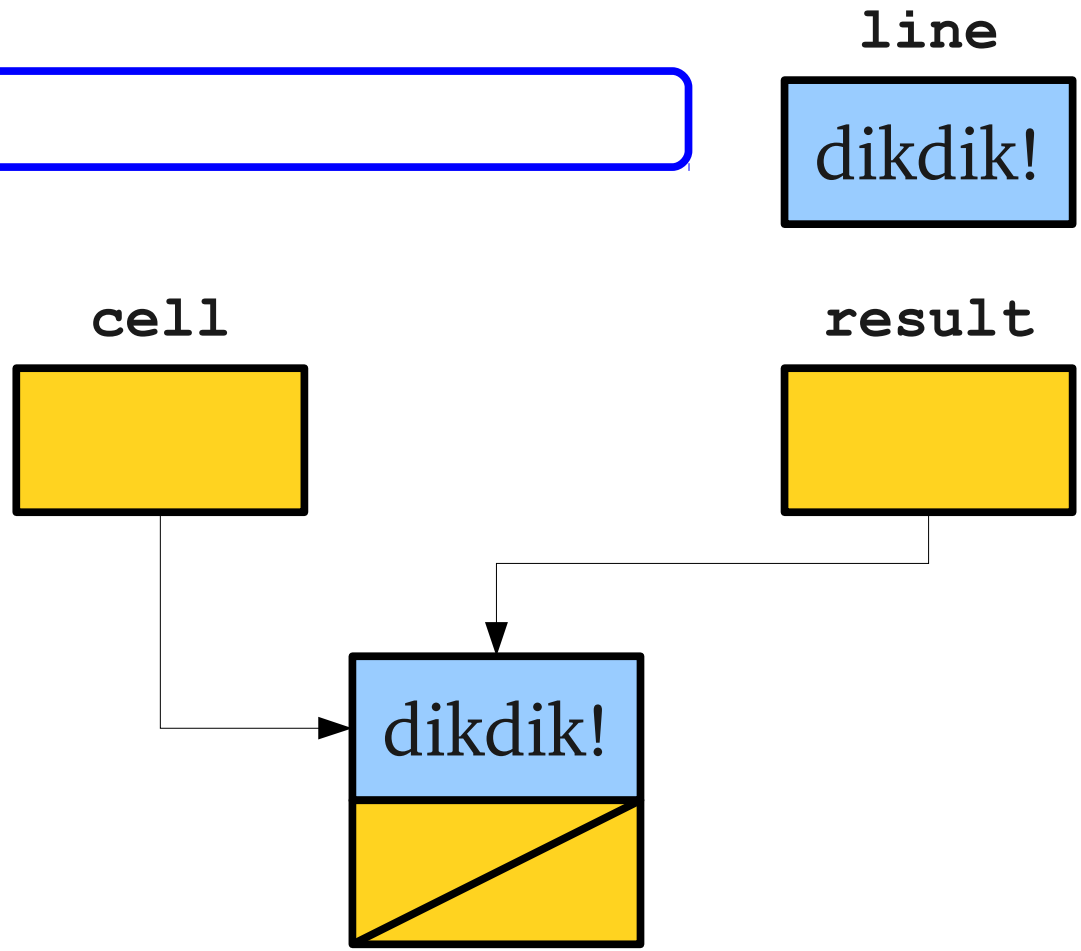

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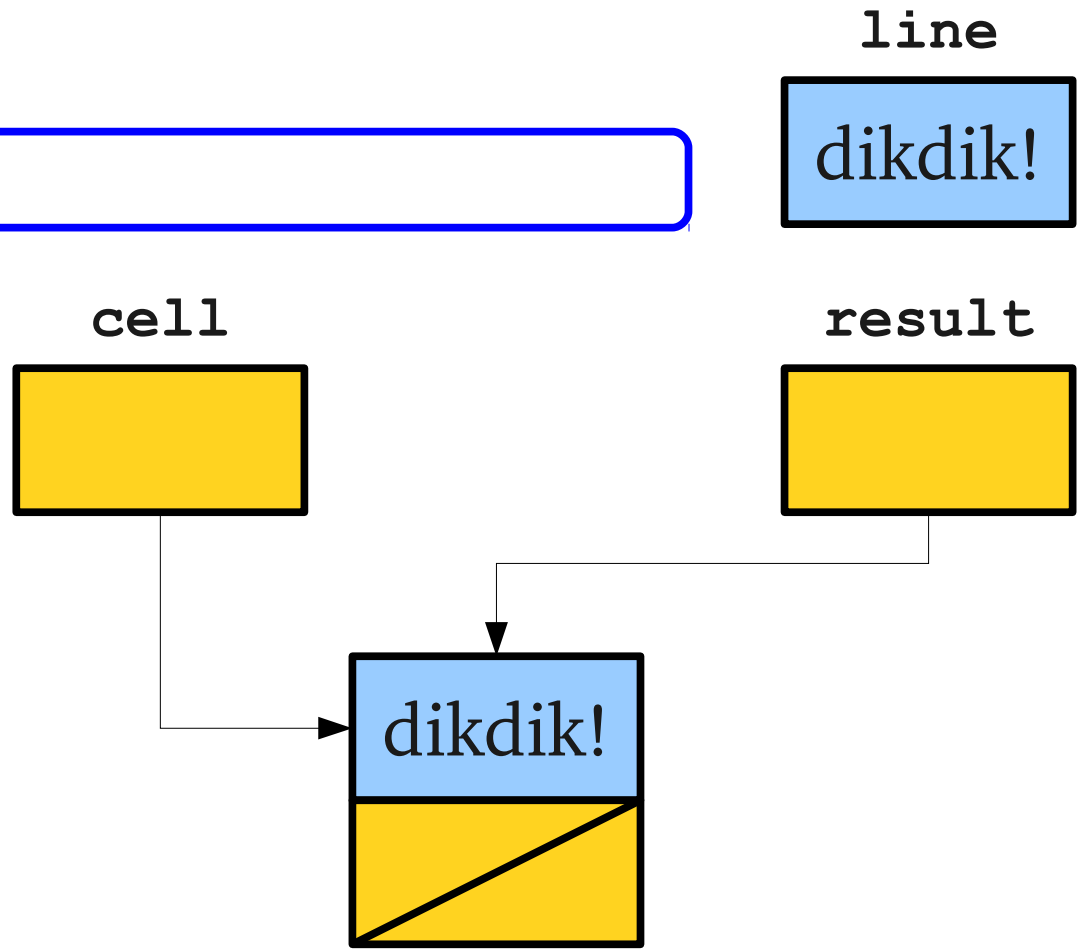

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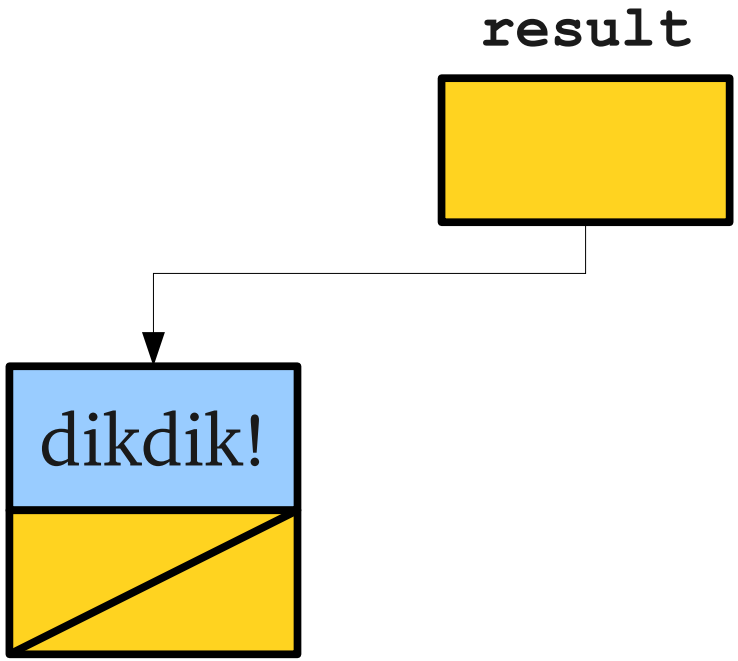

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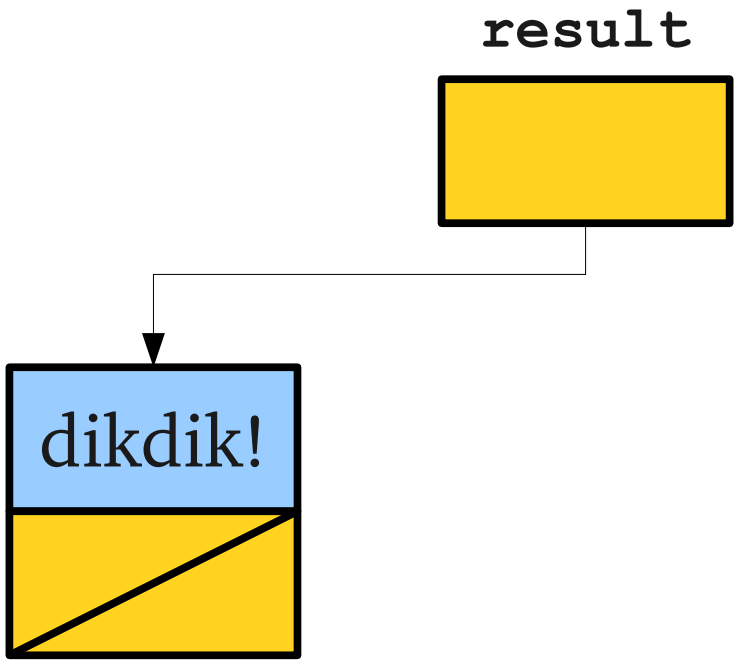

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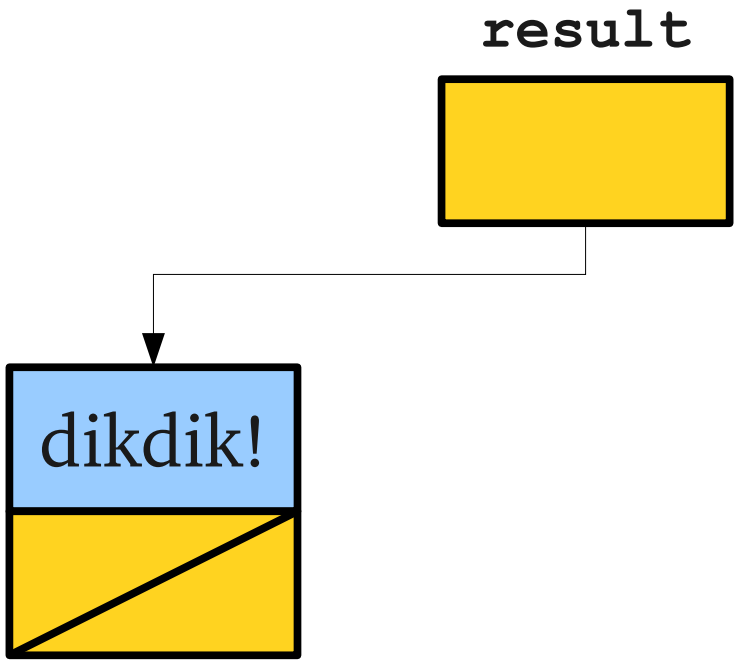

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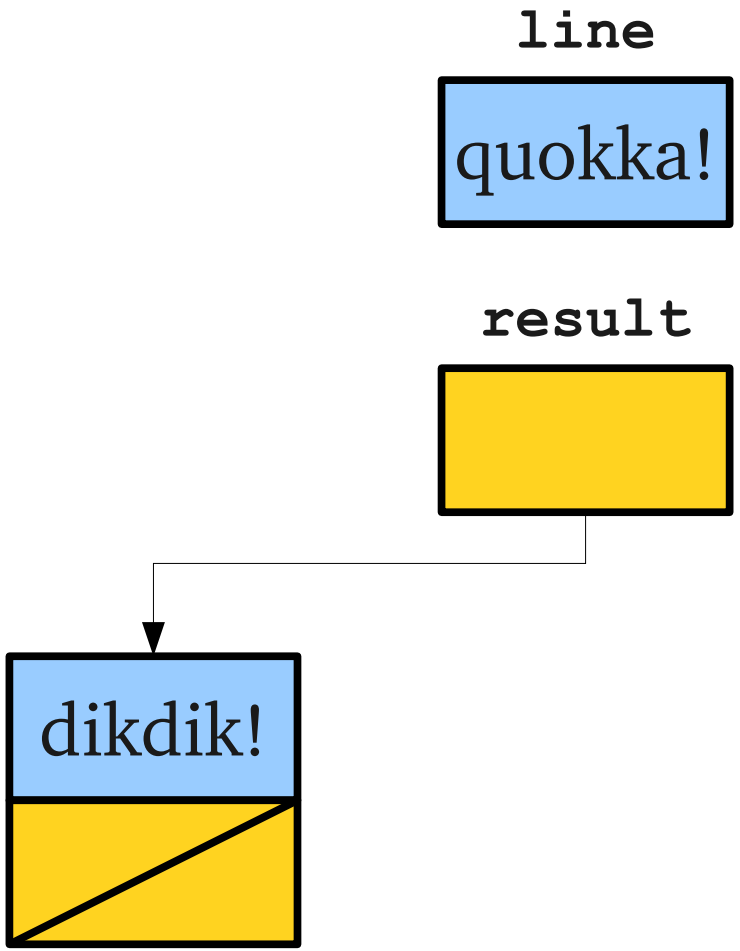

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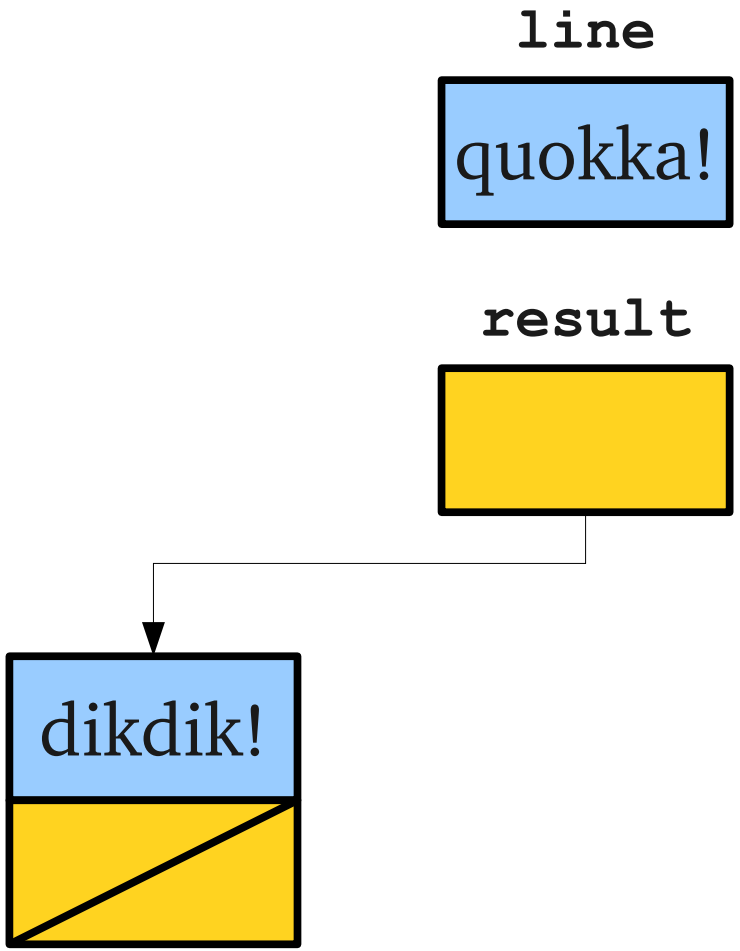

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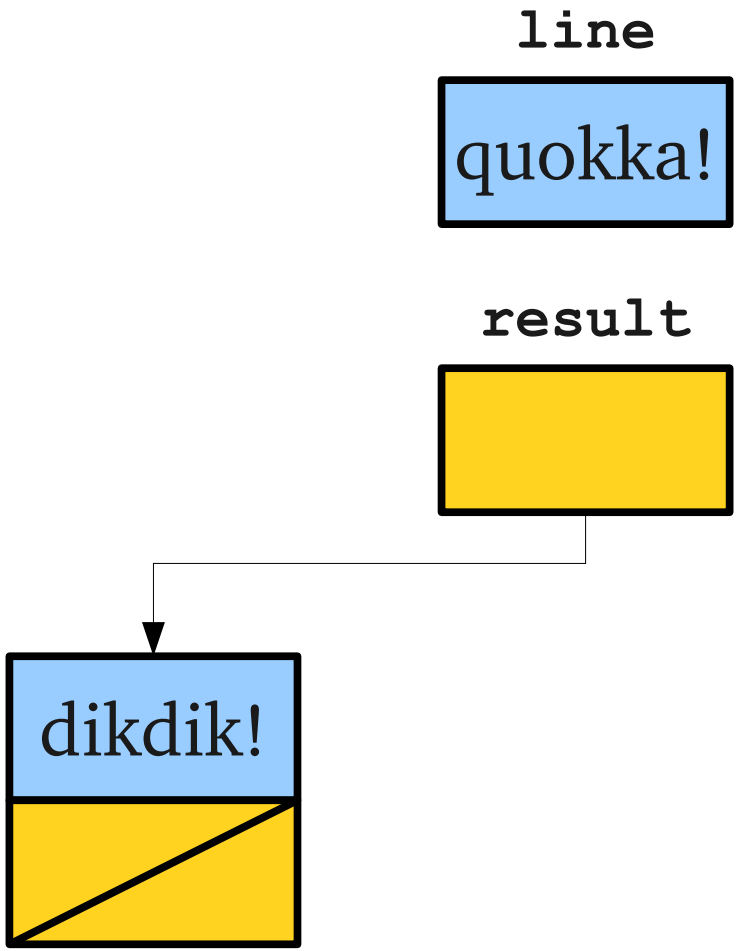

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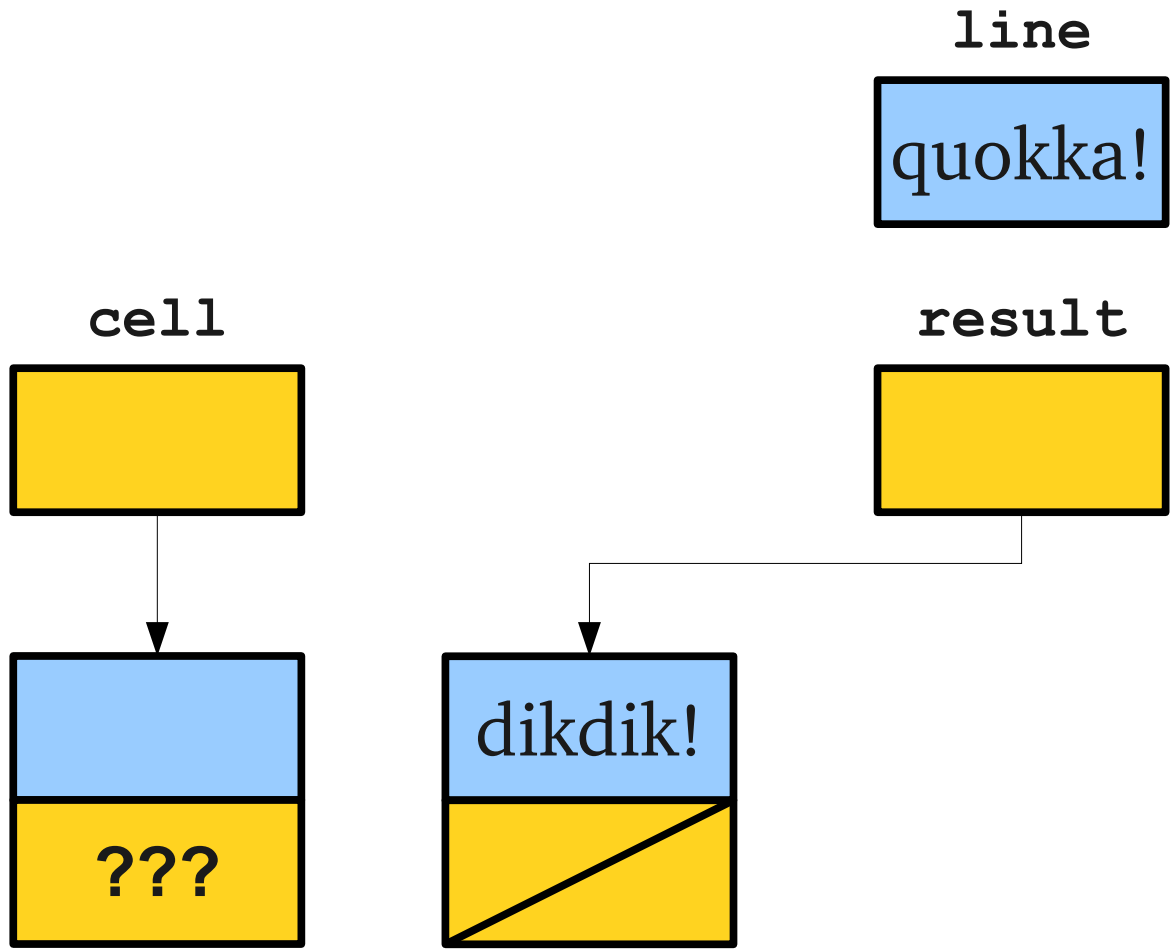

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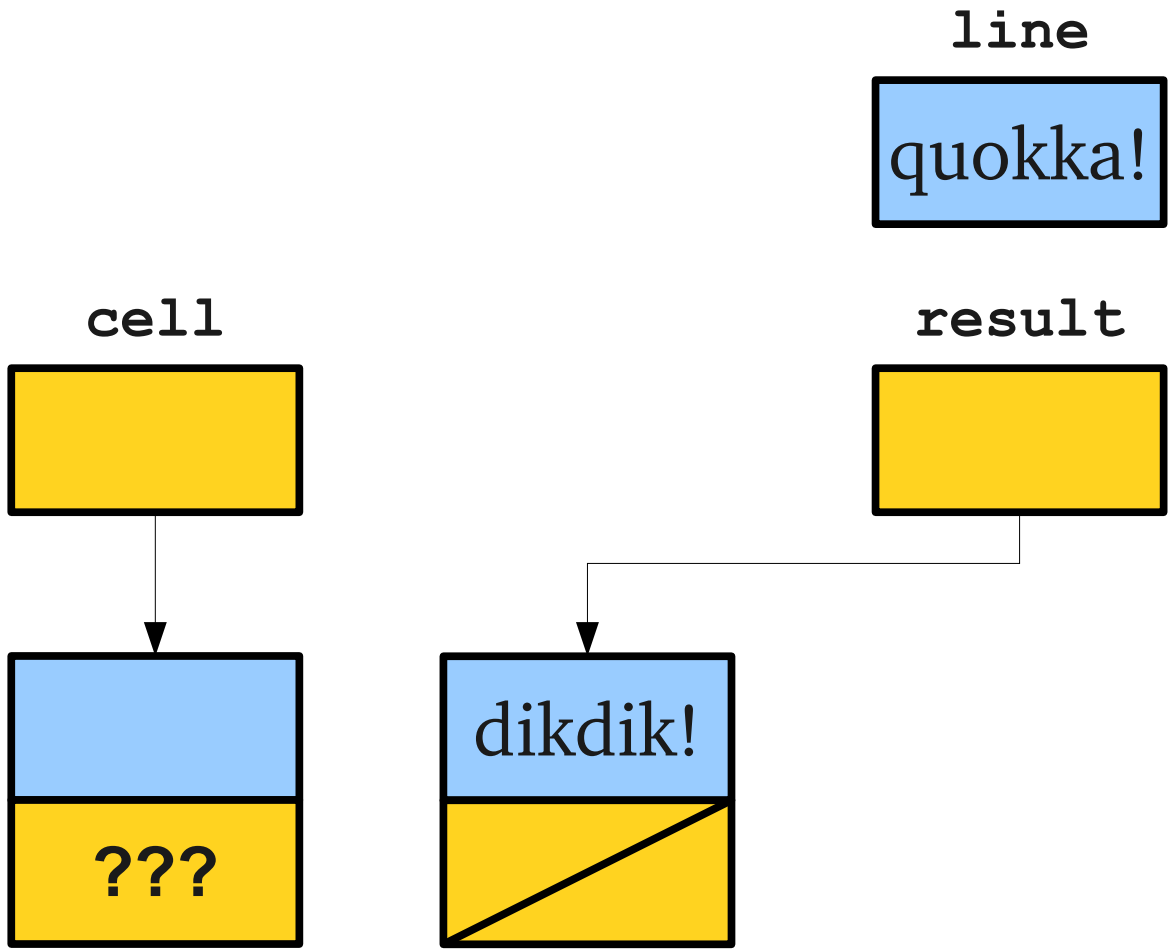

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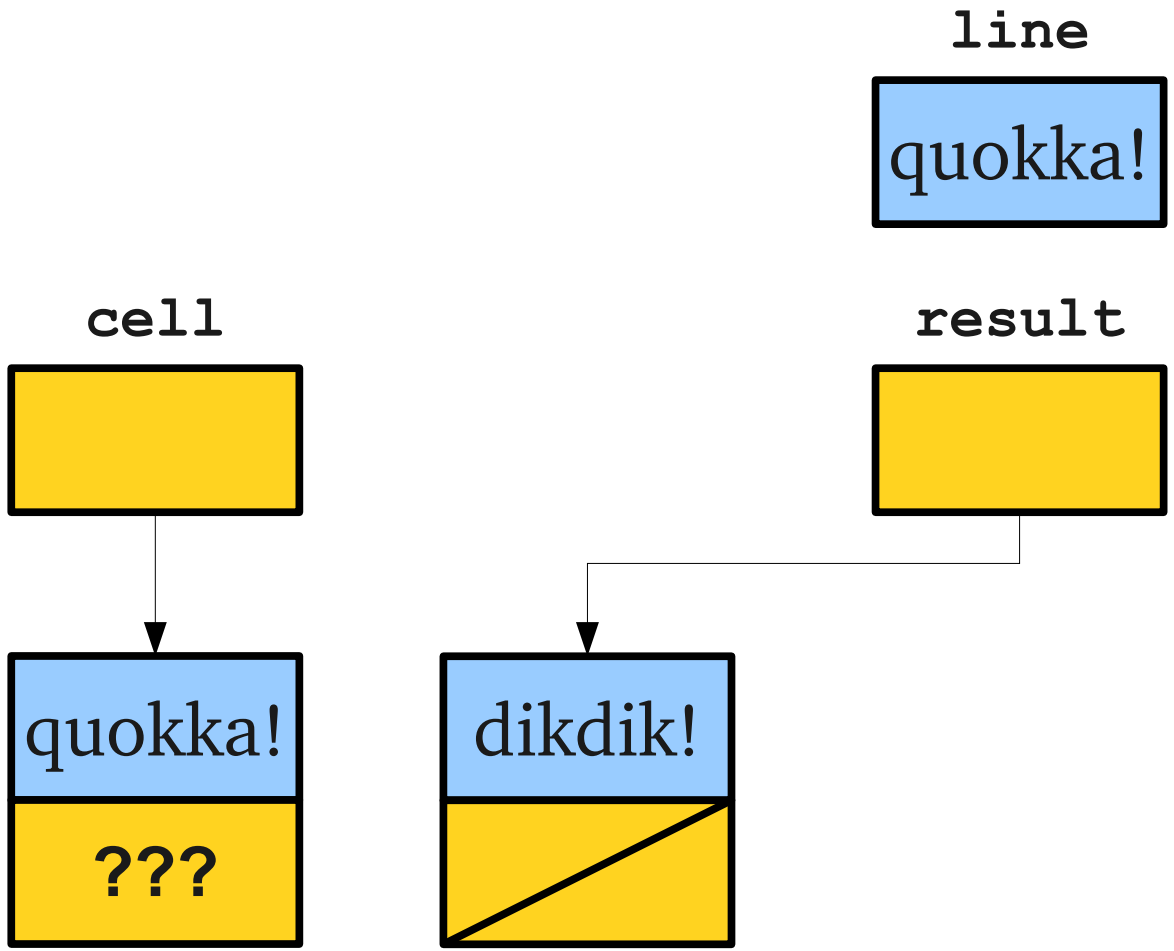

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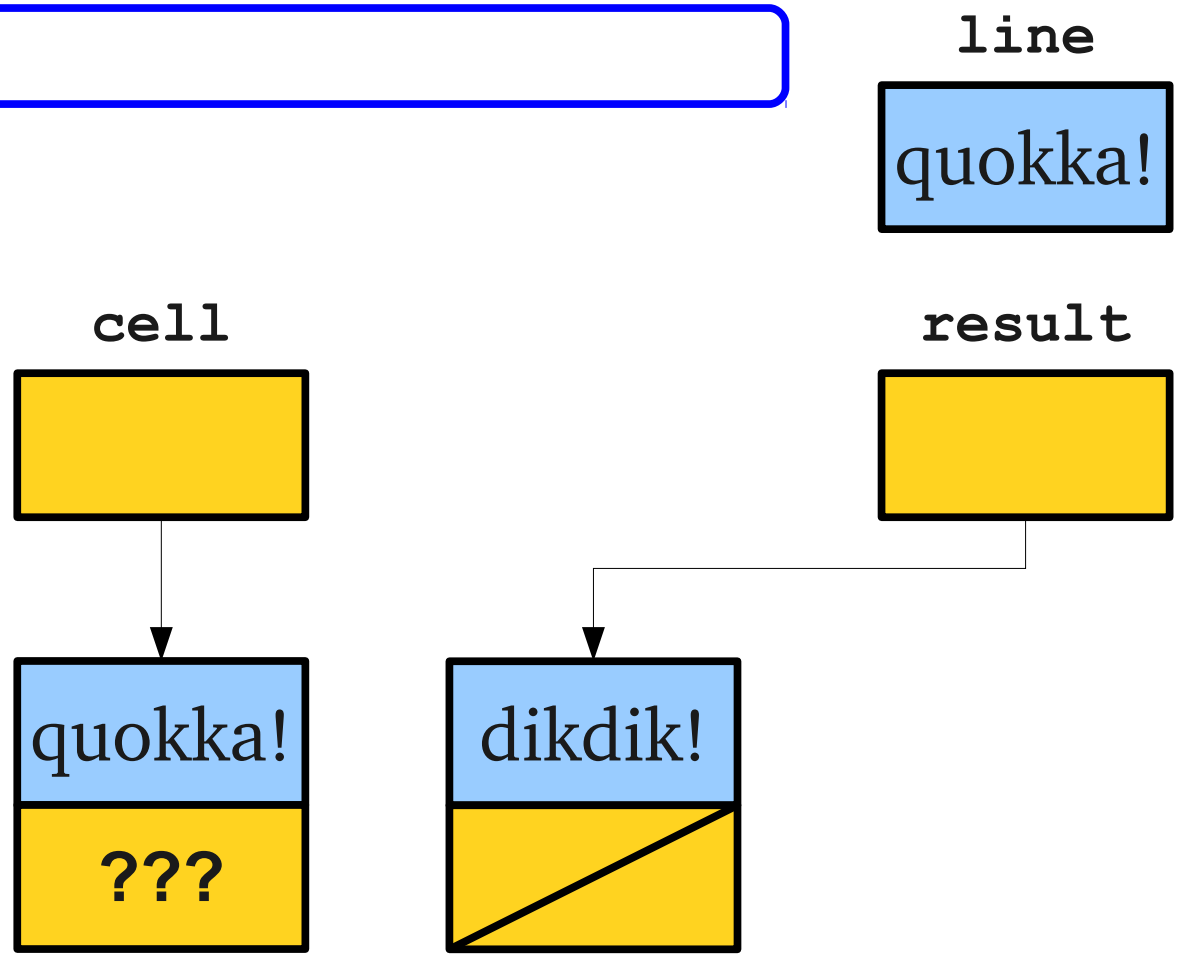

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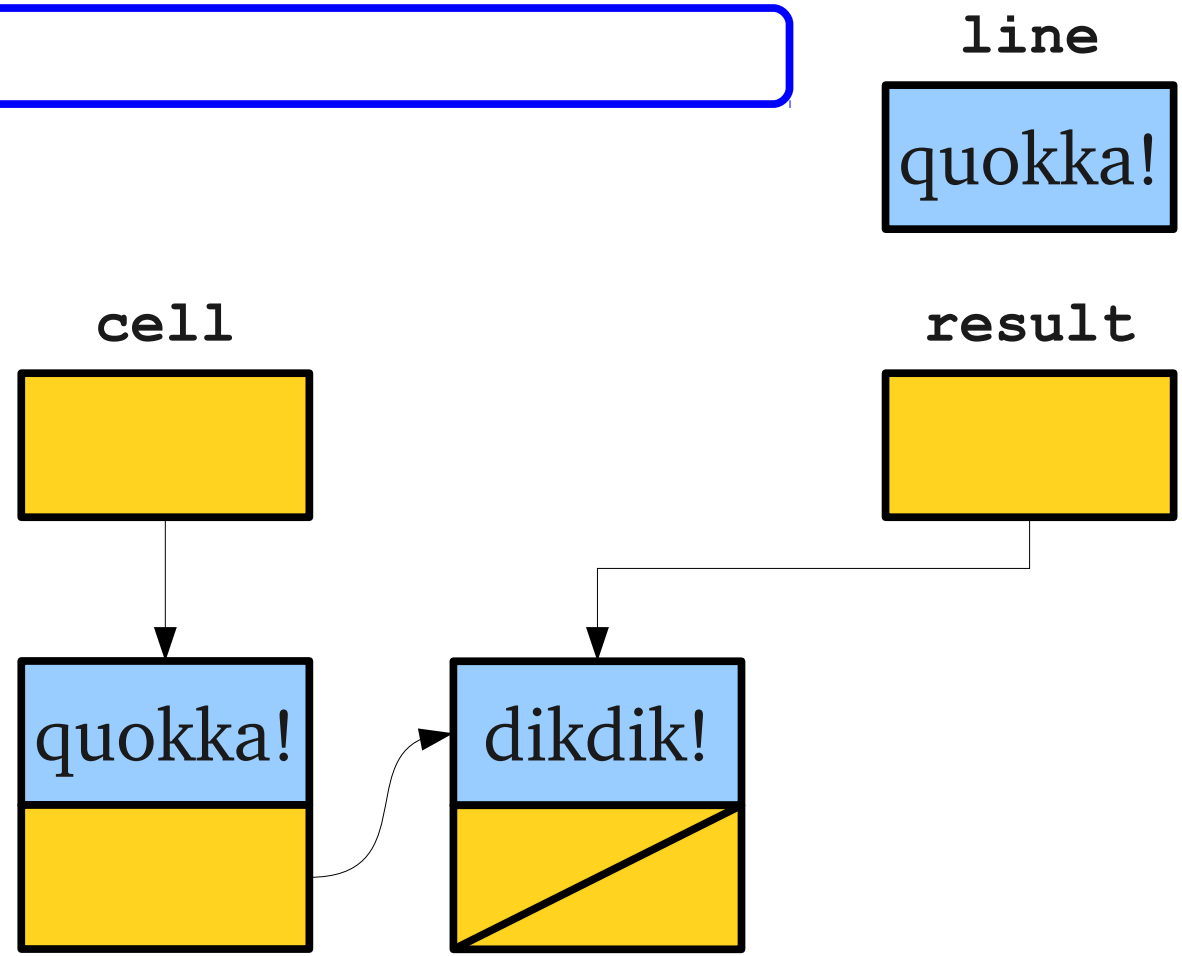

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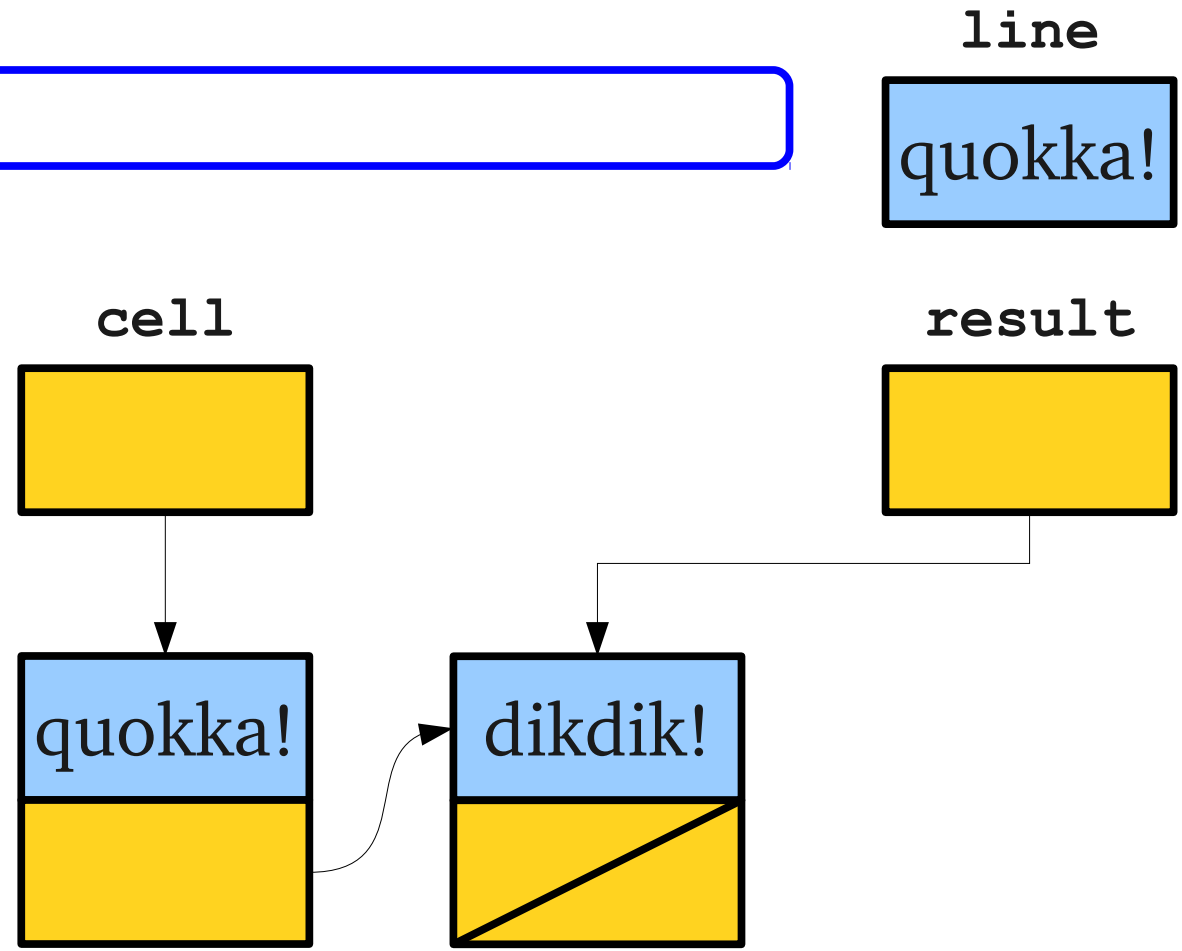

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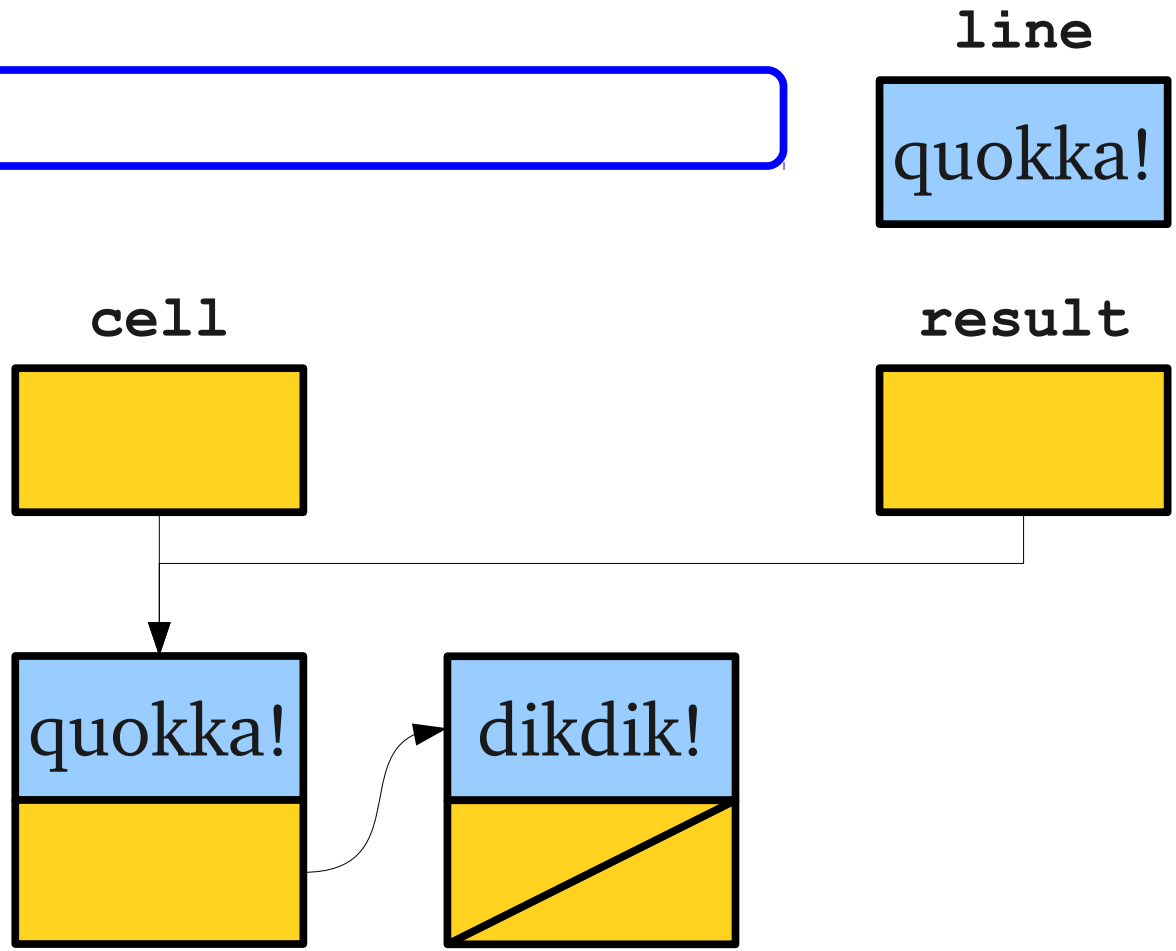

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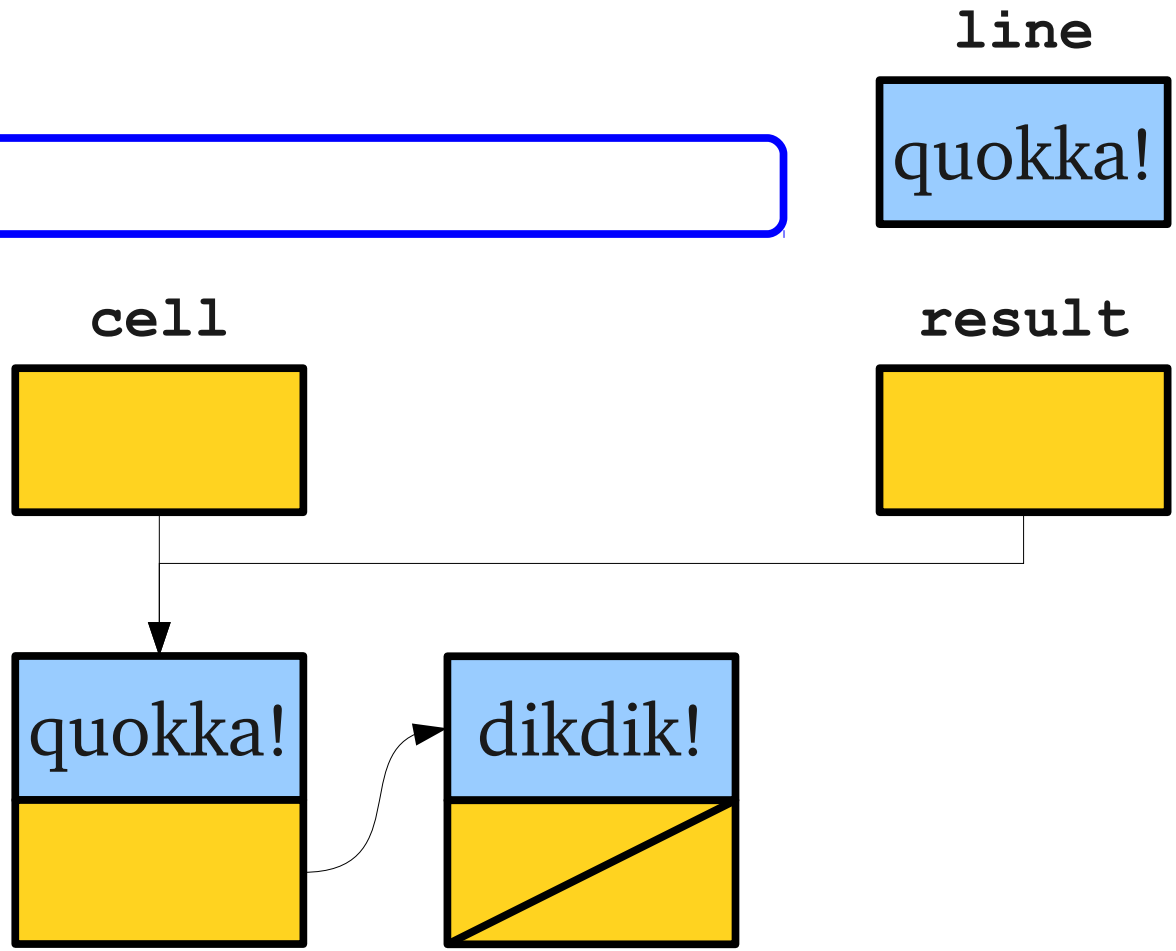

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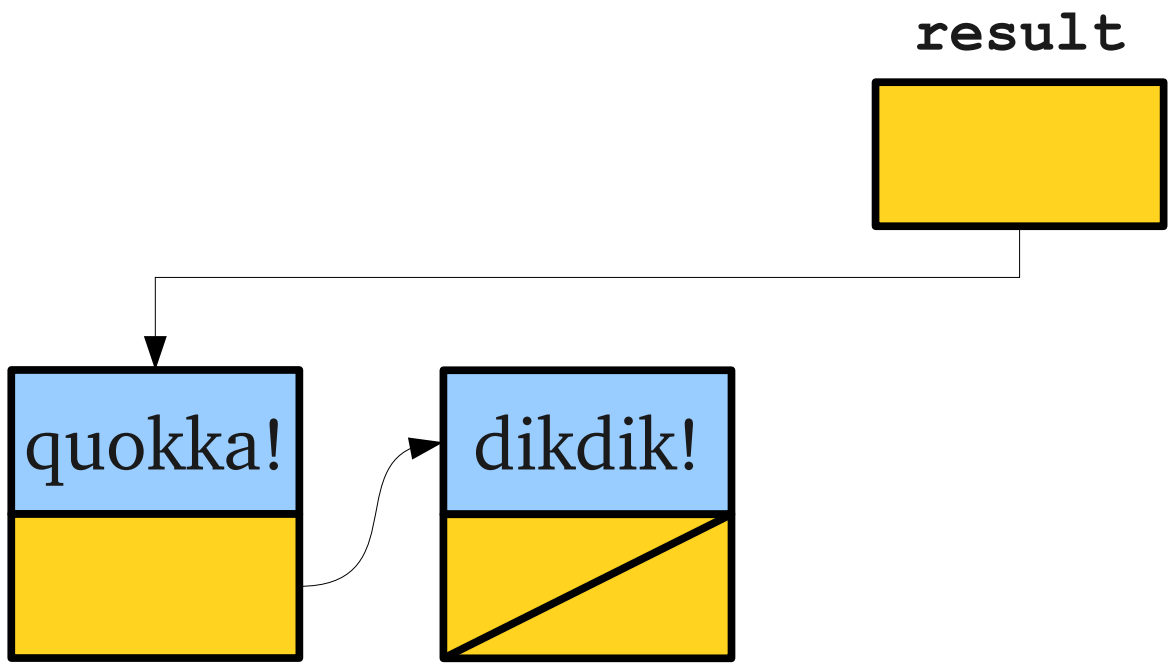

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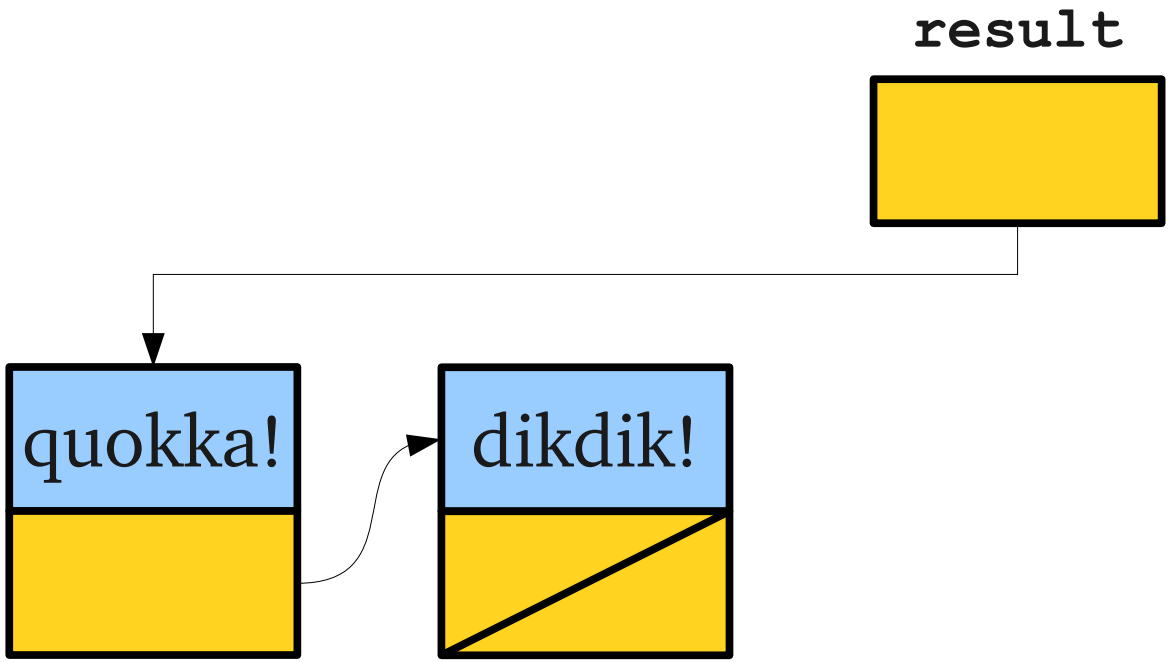

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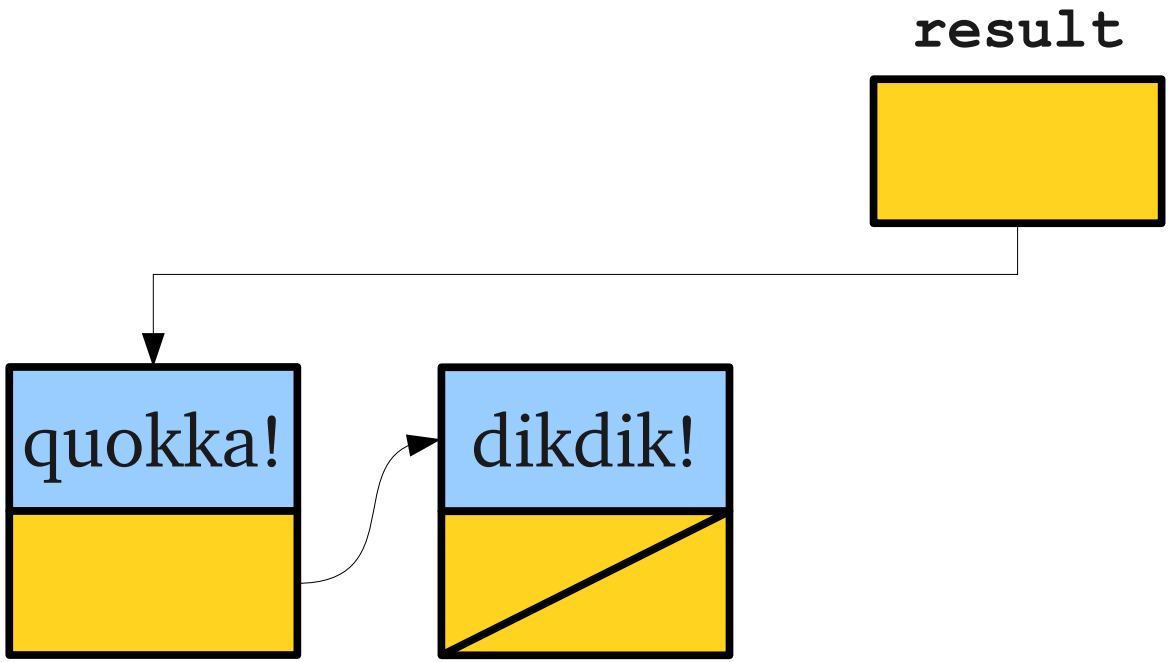

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    string line = getLine("Next entry? ");
    if (line == "") break;

    Cell* cell = new Cell;
    cell->value = line;

    cell->next = result;
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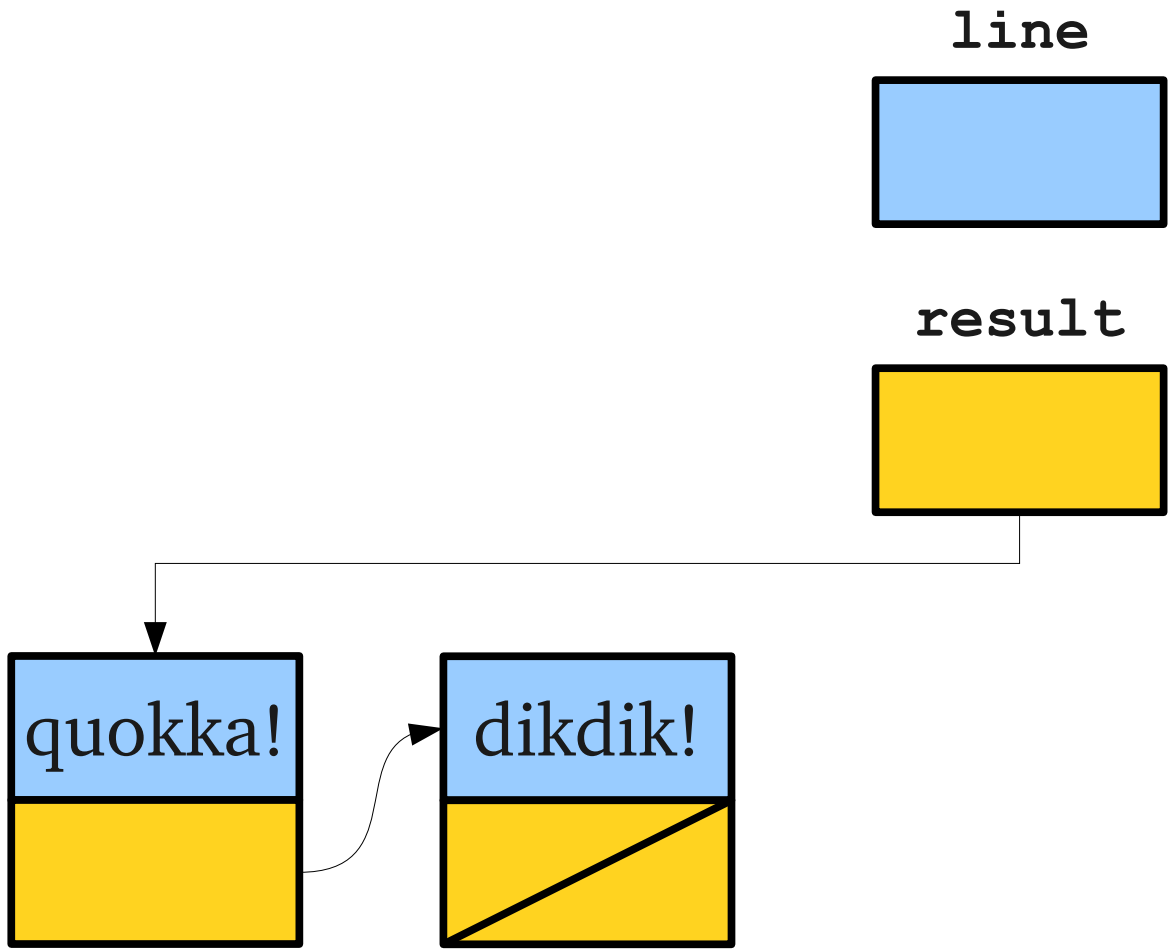

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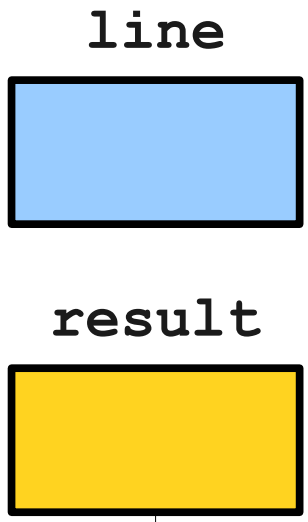

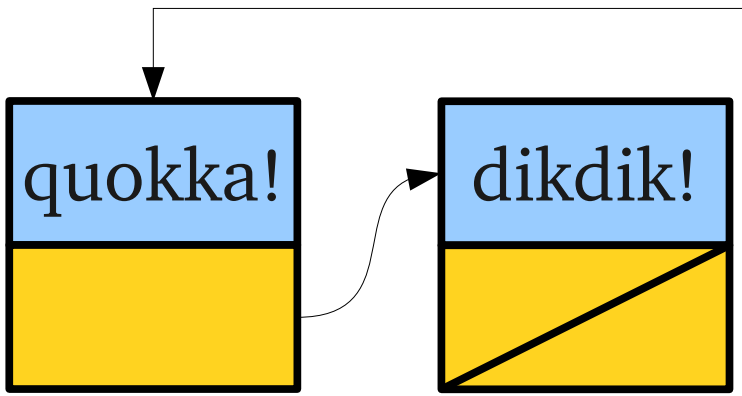

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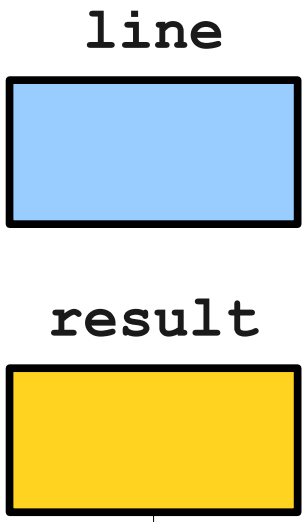

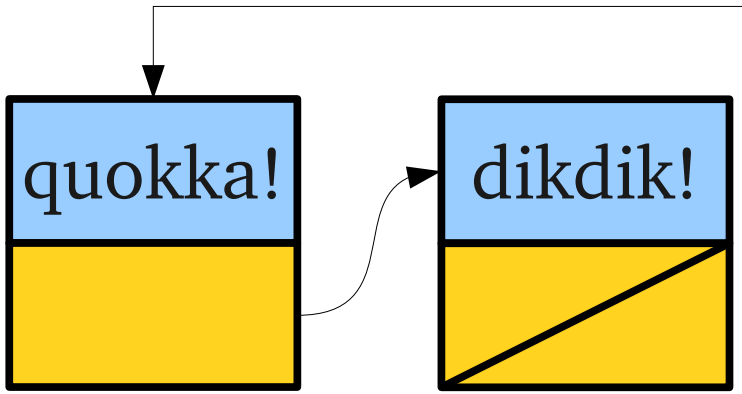

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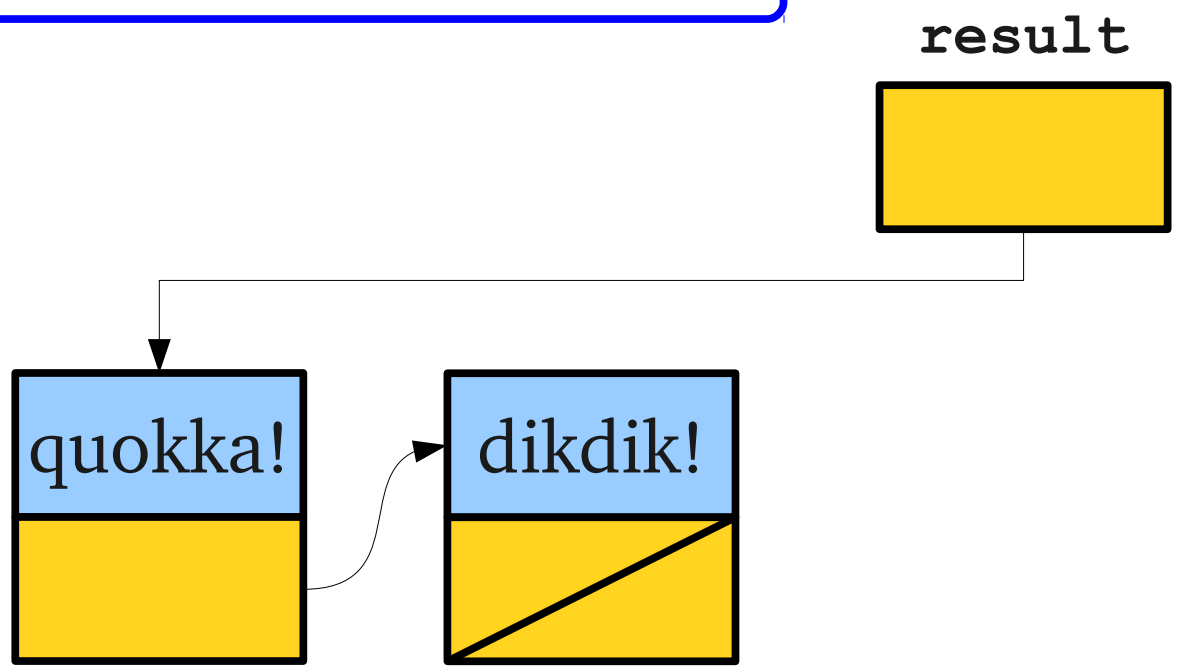
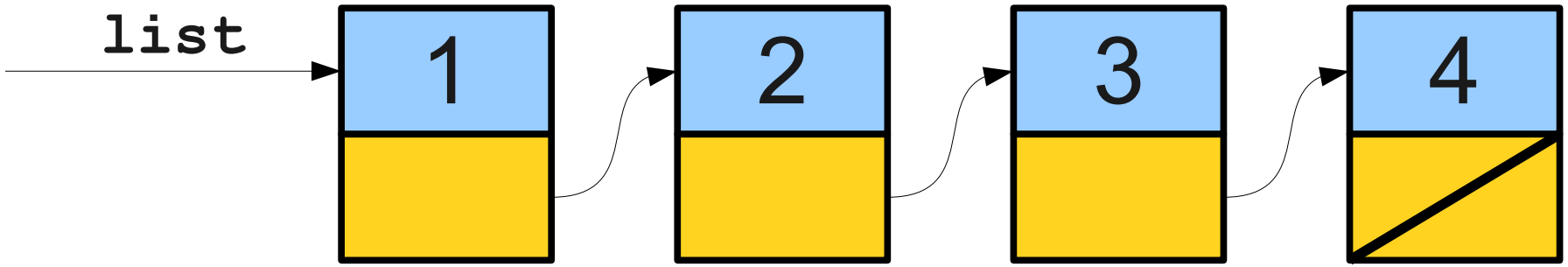


Traversing a Linked List

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

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



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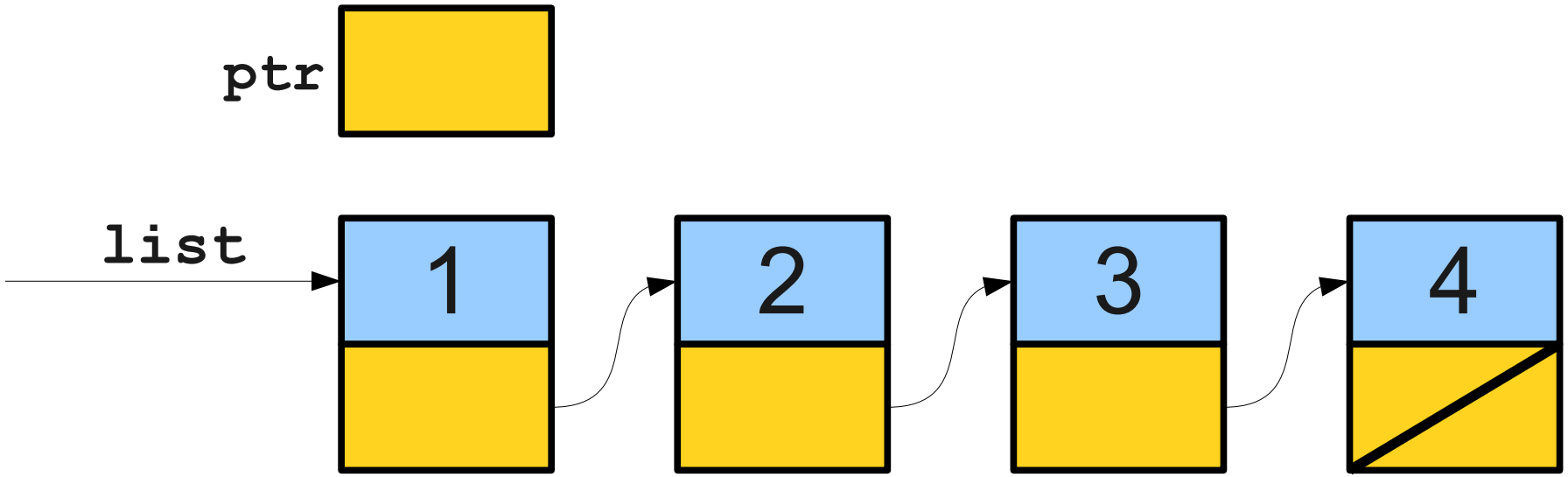

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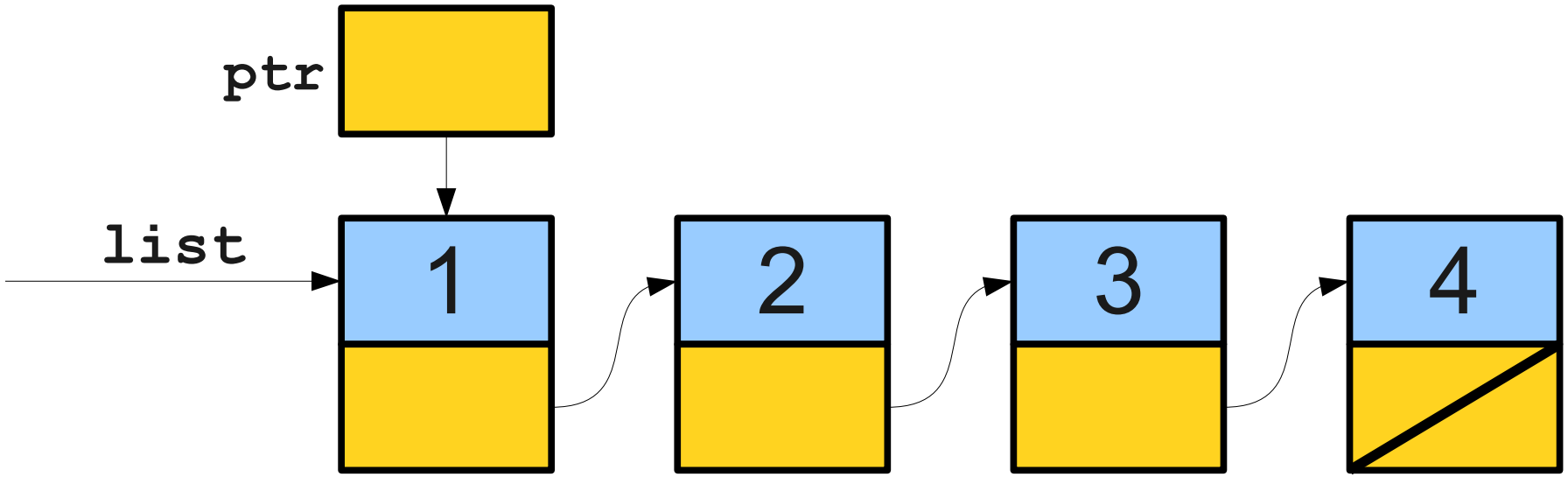

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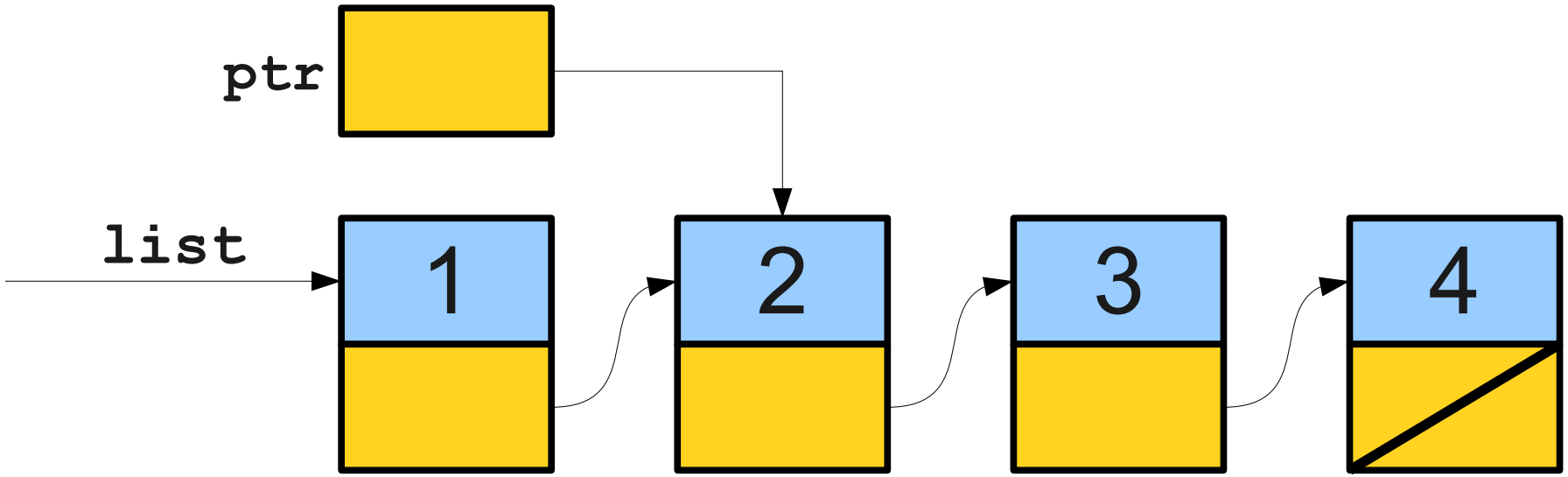

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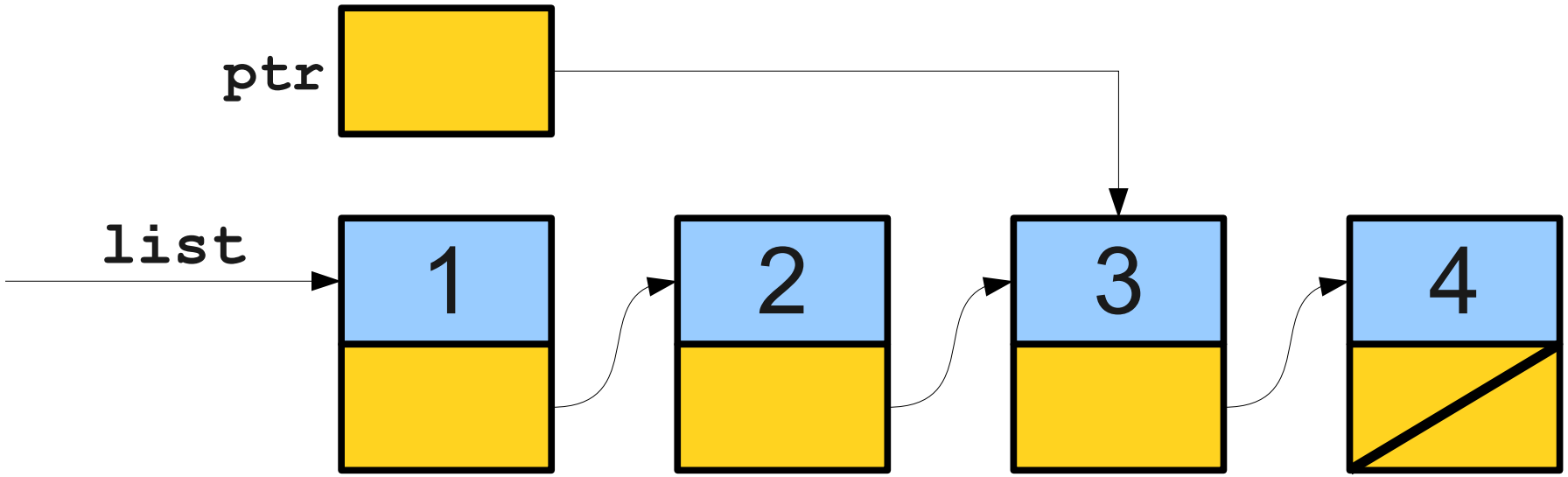

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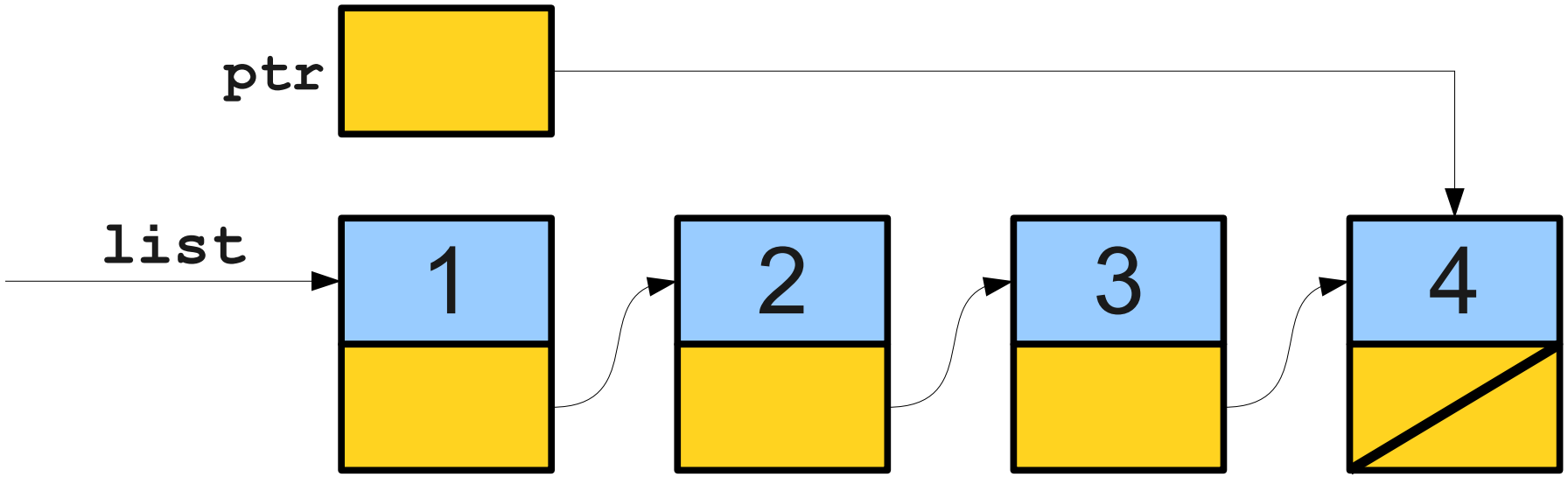

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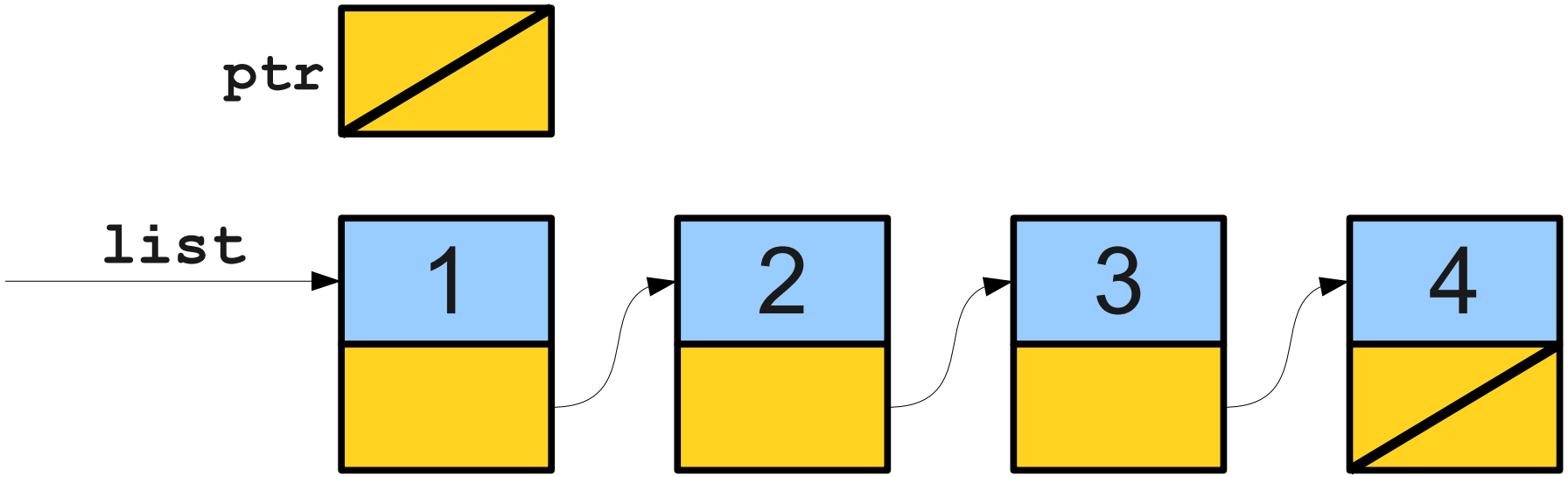

Once More With Recursion

- Linked lists are defined recursively, and we can traverse them using recursion!

```
void recursiveTraverse(Cell* list) {
    if (list == NULL) return;
    /* … do something with list … */
    recursiveTraverse(list->next);
}
```

Freeing a Linked List

- All good things must come to an end, and we eventually need to reclaim the memory for a linked list.
- Here's an ***Extremely Bad Idea***:

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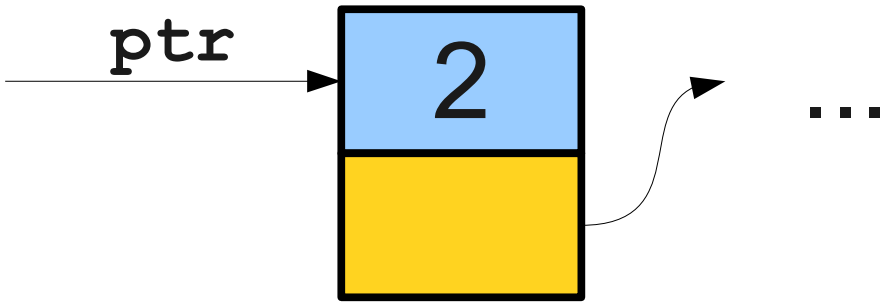

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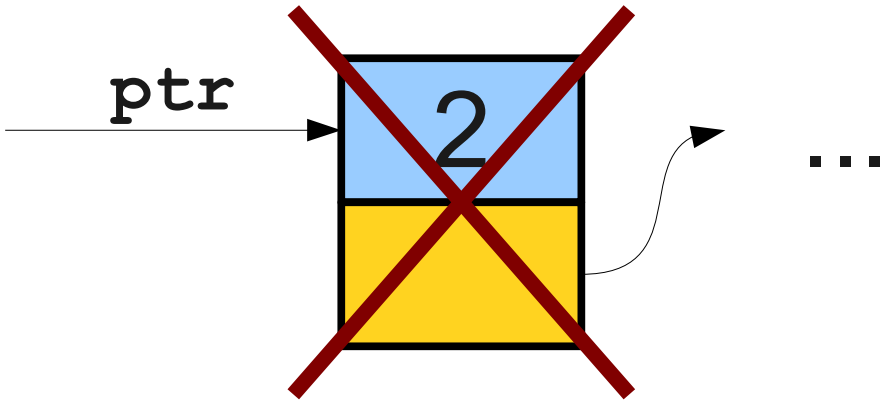

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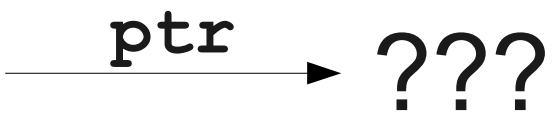

Freeing a Linked List Properly

- 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?

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 = NULL;
    listInsert(list, 137);
    listInsert(list, 42);
    listInsert(list, 271);
}
```

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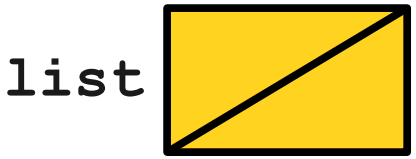

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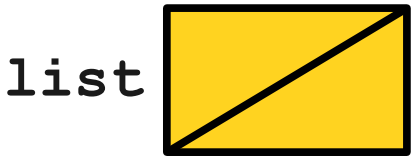

```
int main() {

}
```

```
void listInsert(Cell* list, int value) {
    Cell* newCell = new Cell;
    newCell->value = value;
    newCell->next = list;
    list = newCell;
}
```

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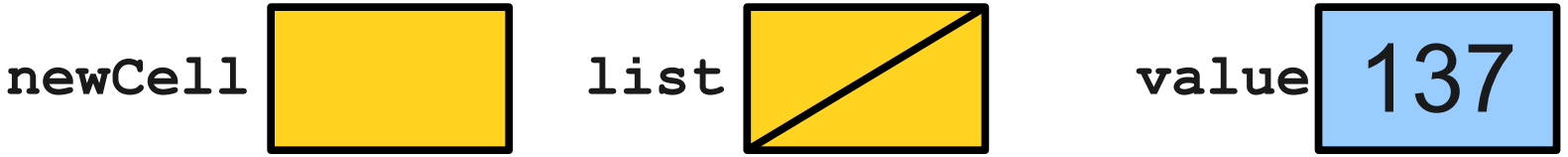

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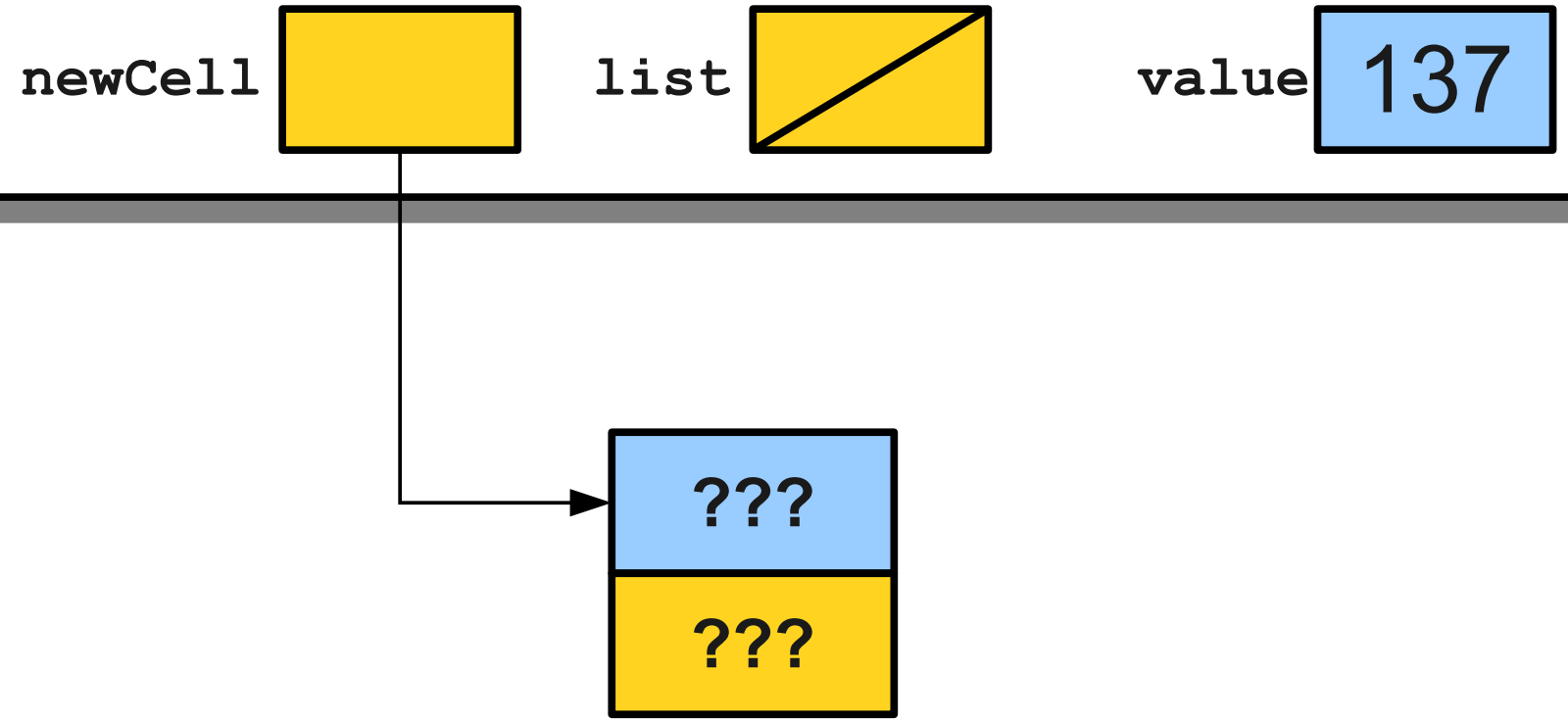

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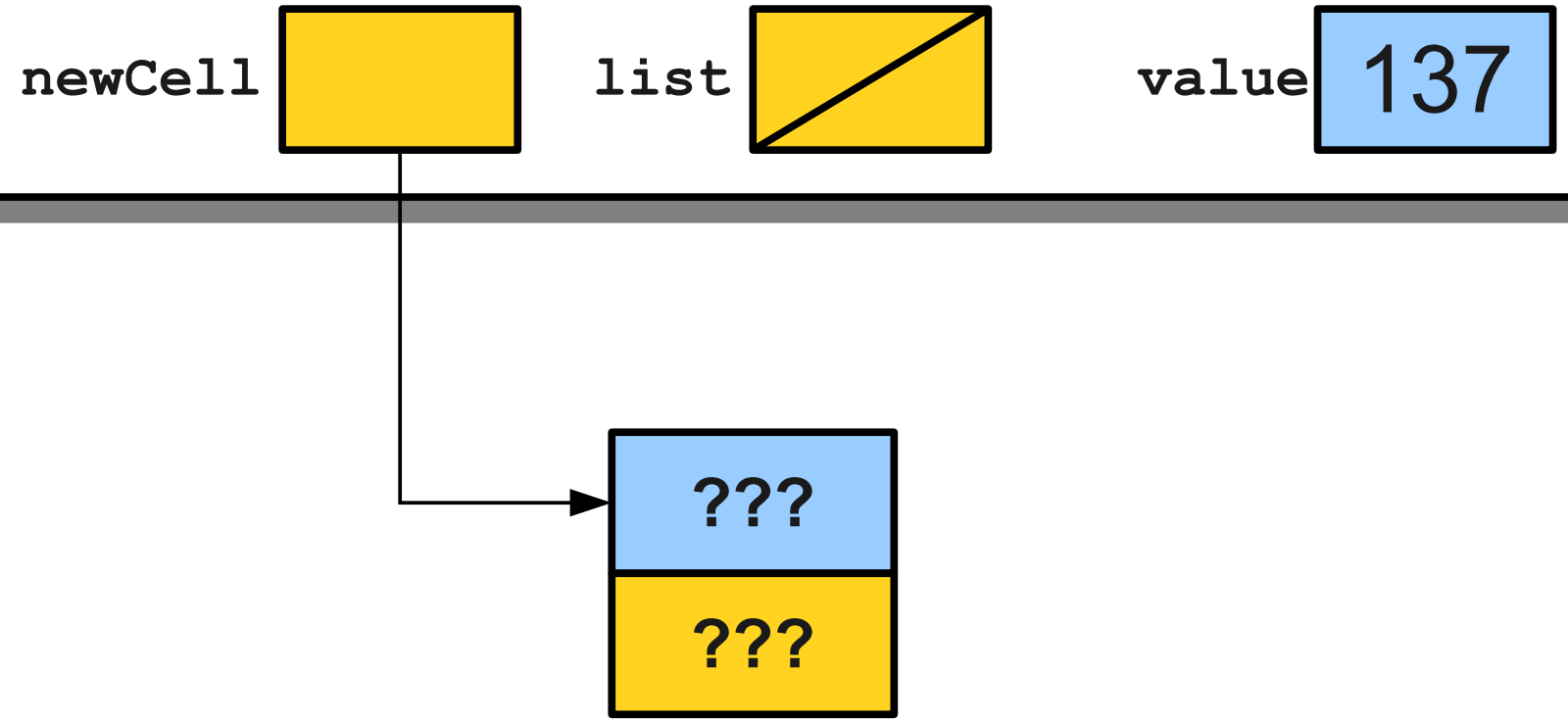

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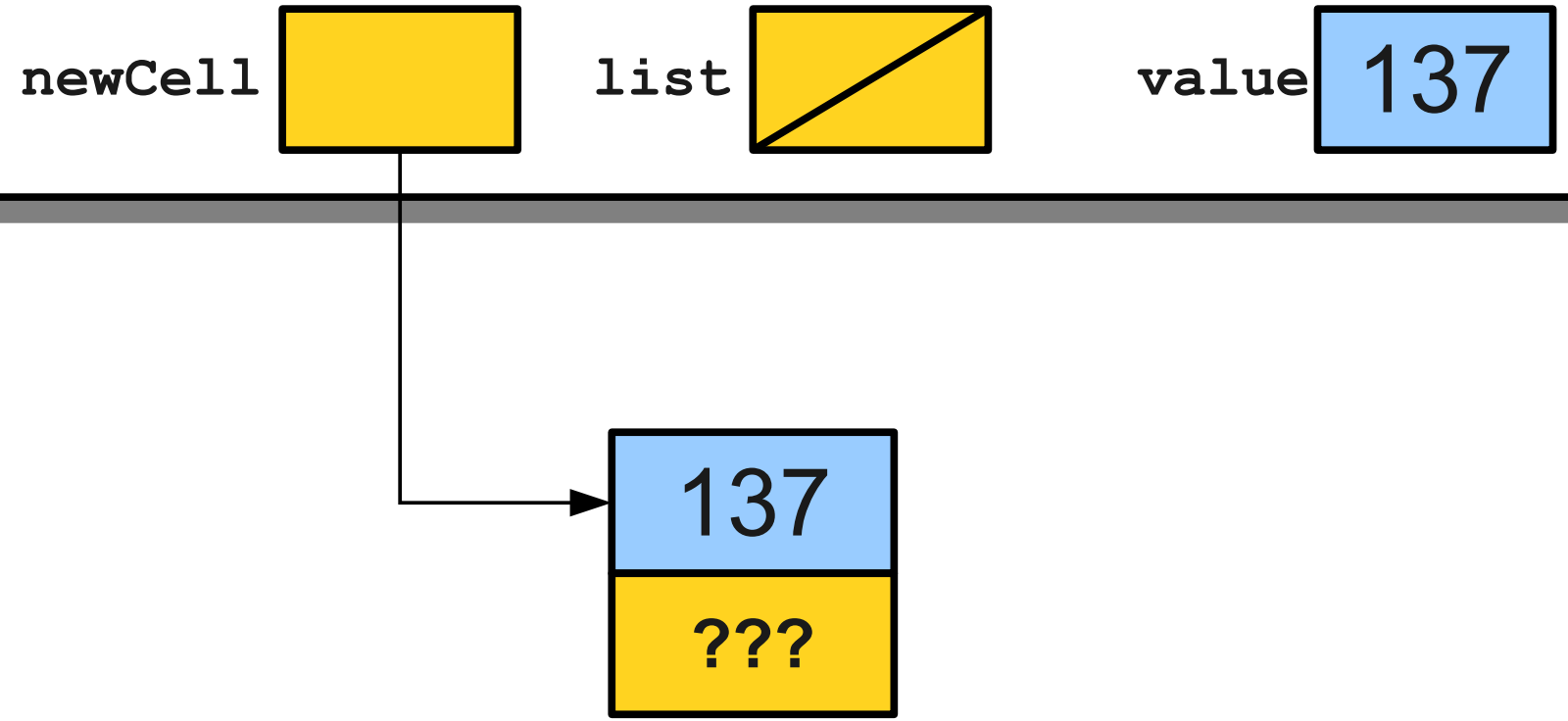

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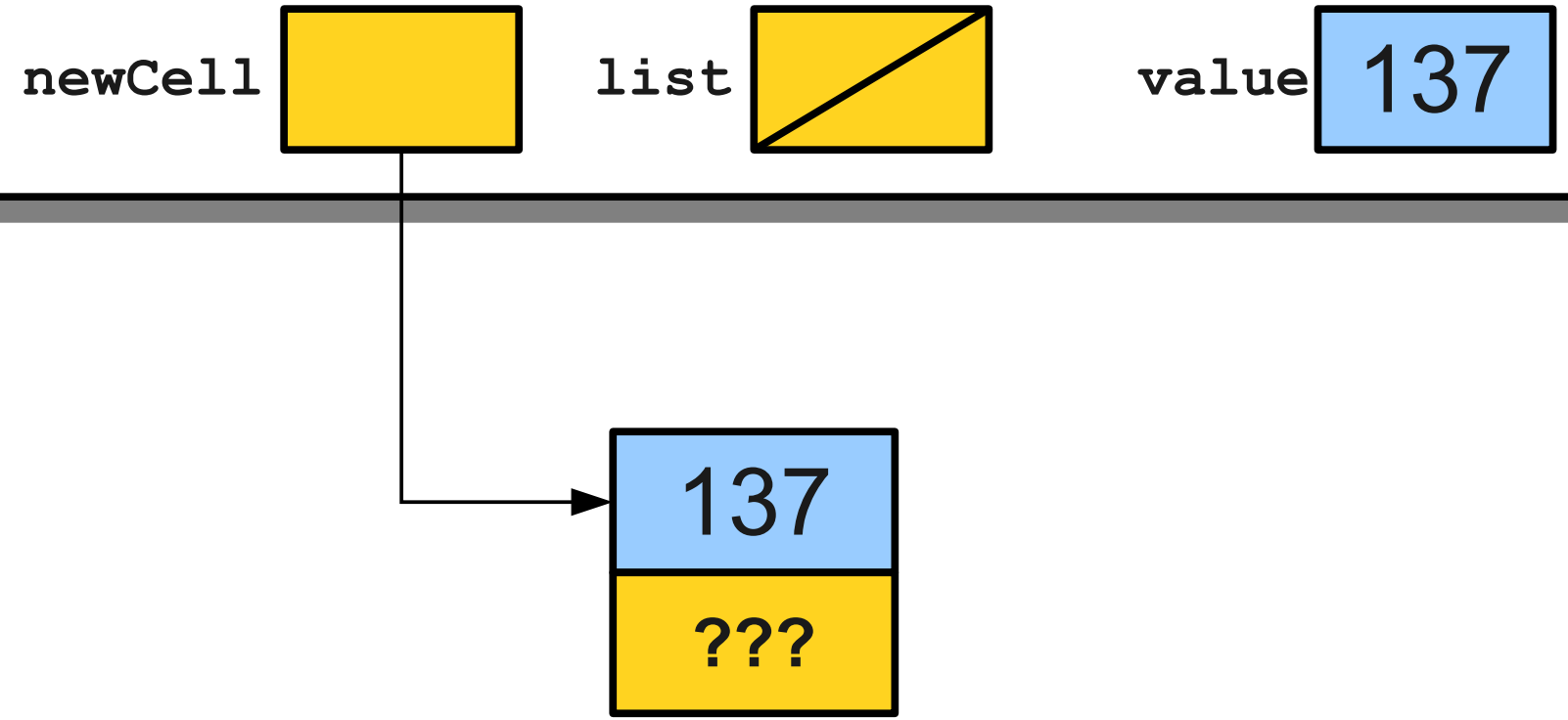

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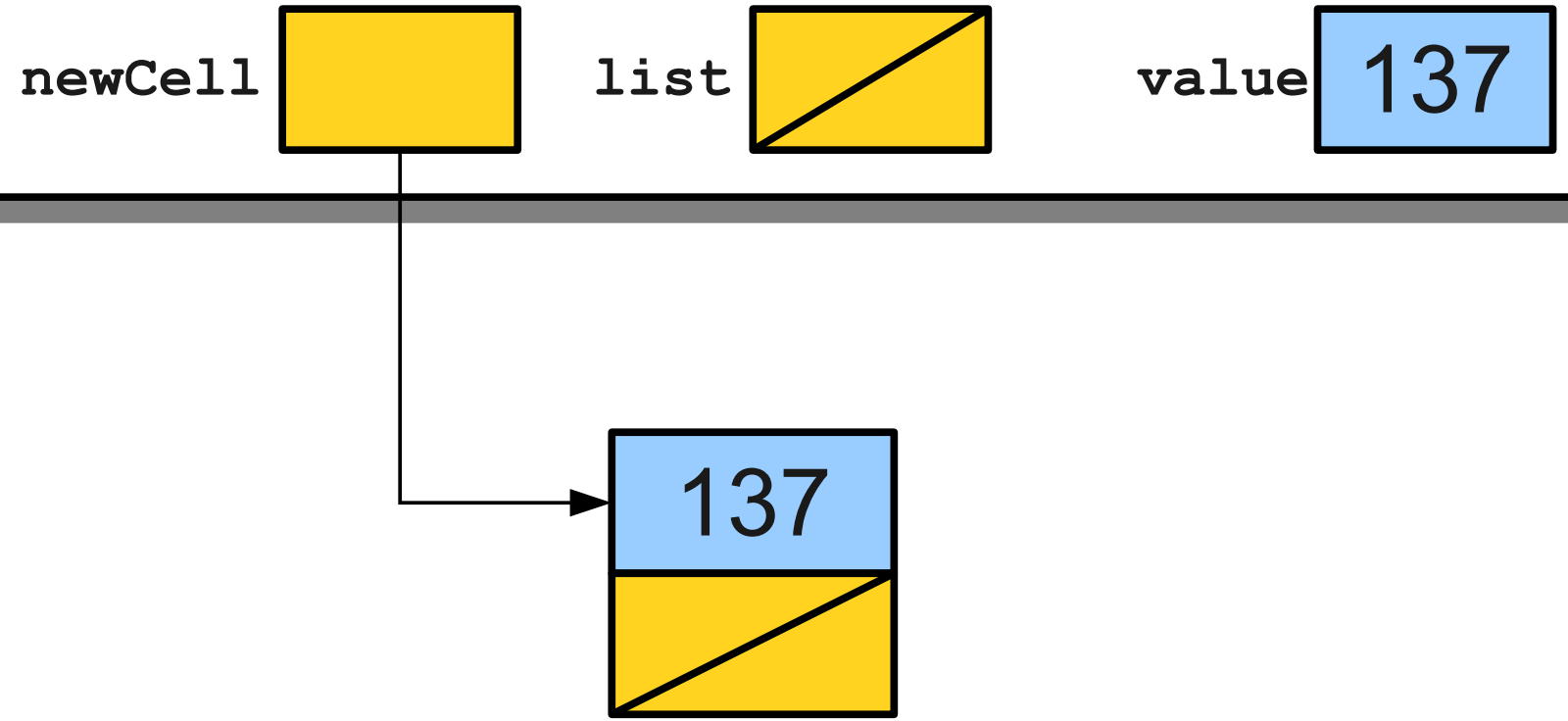

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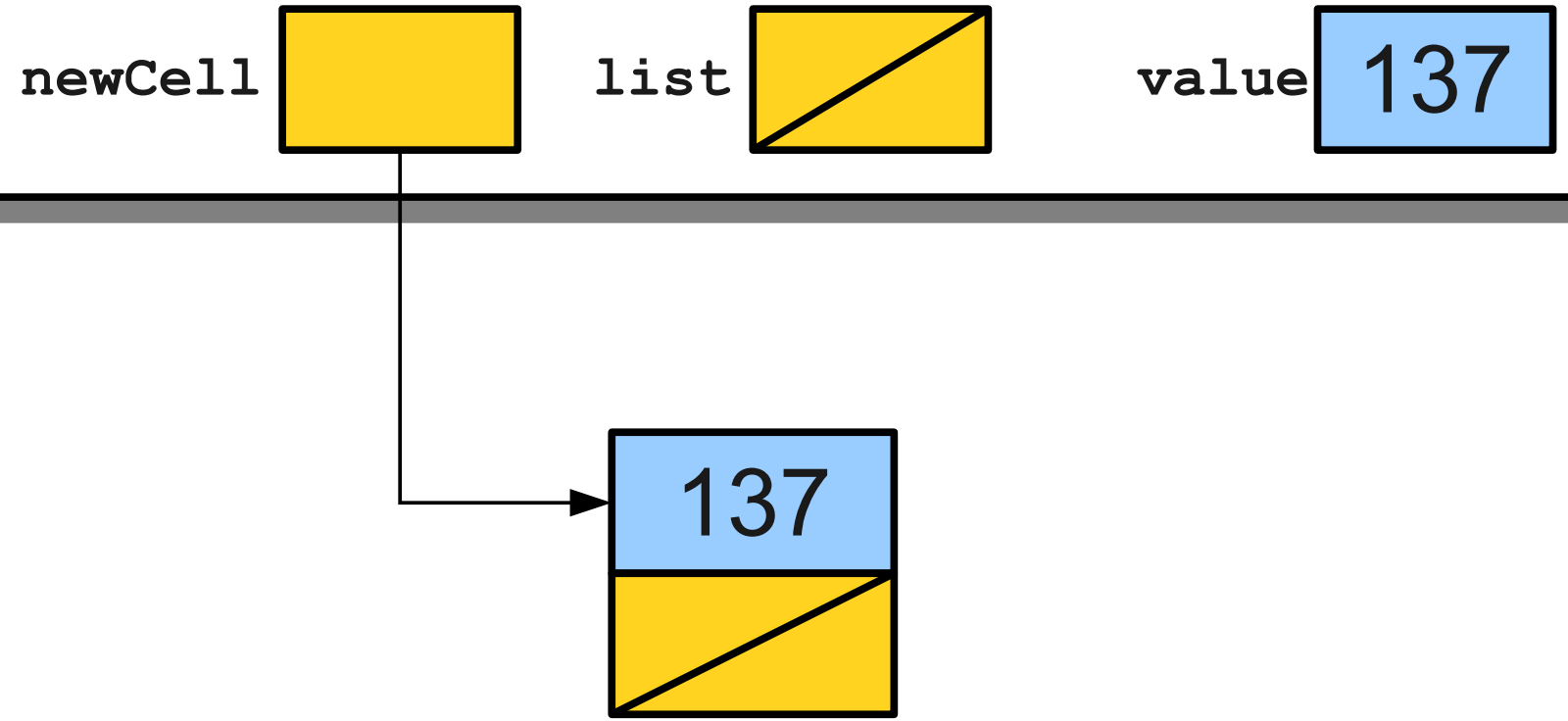

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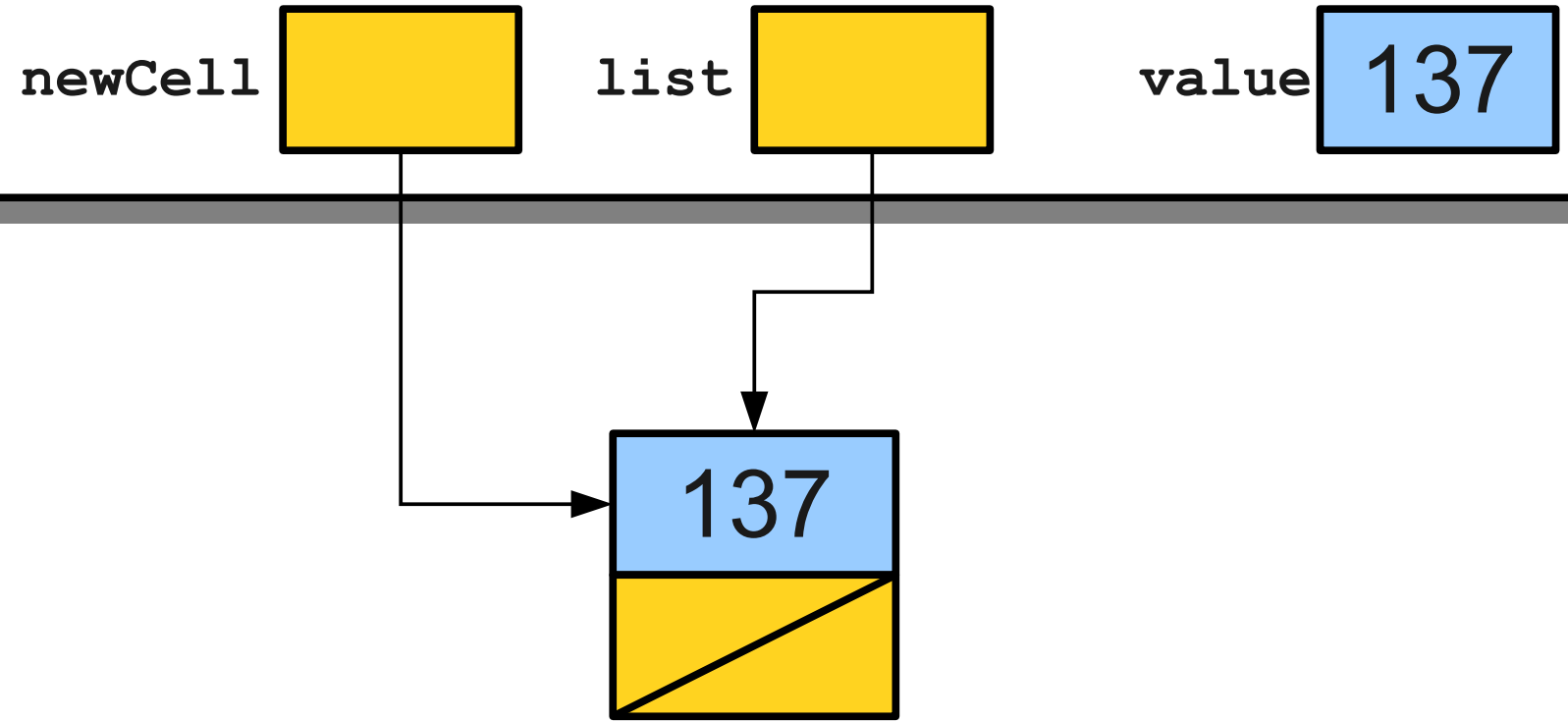

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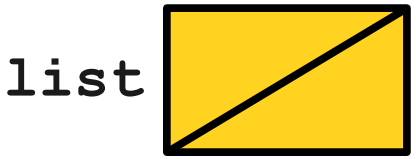

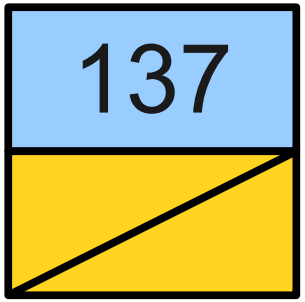

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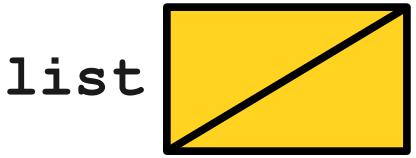

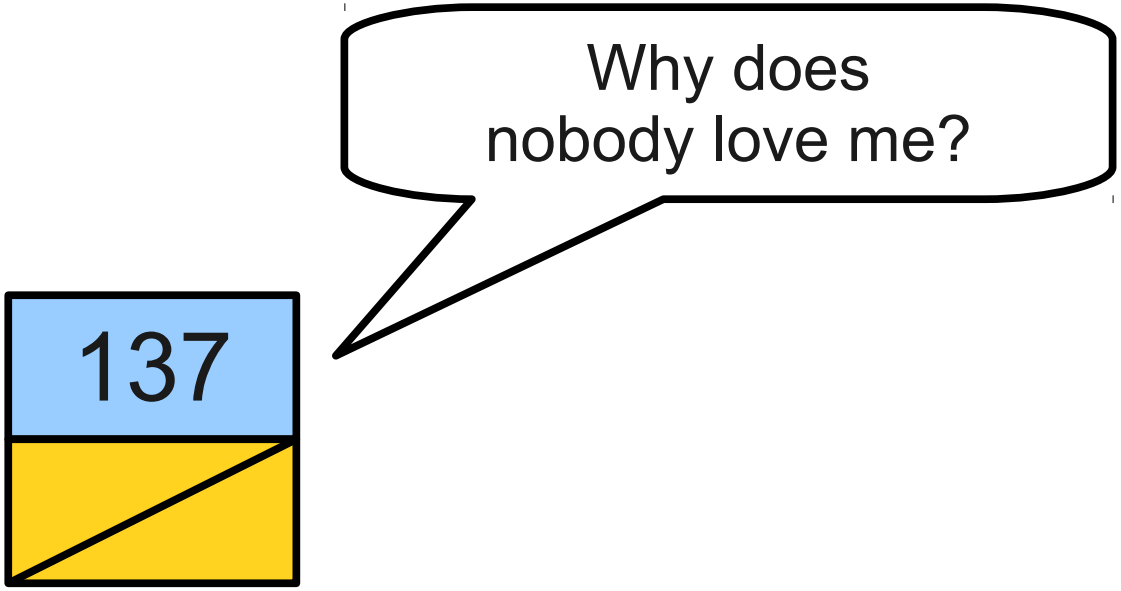

Pointers by Reference

- In order to resolve this problem, we must pass the linked list pointer by reference.
- Our new function:

```
void listInsert(Cell*& list, int value) {
    Cell* newCell = new Cell;
    cell->value = value;
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void listInsert(Cell*& list, int value) {
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    cell->value = va
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}
```

This is a reference to a pointer to a Cell. It's often useful to read this from the right to the left.

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int main() {
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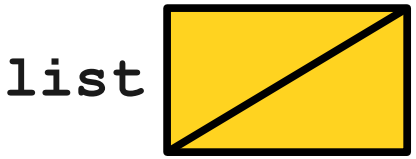

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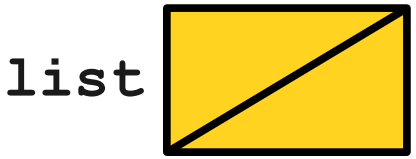

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int main() {
    Cell* list = N
    listInsert(lis
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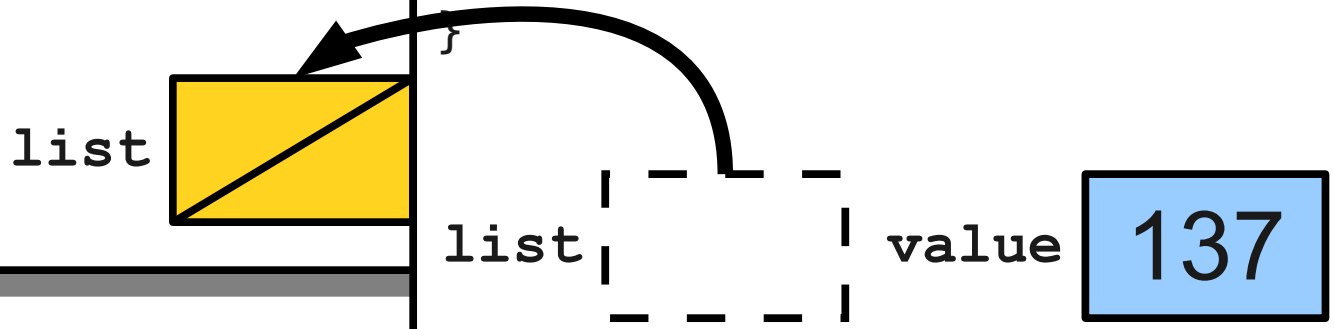

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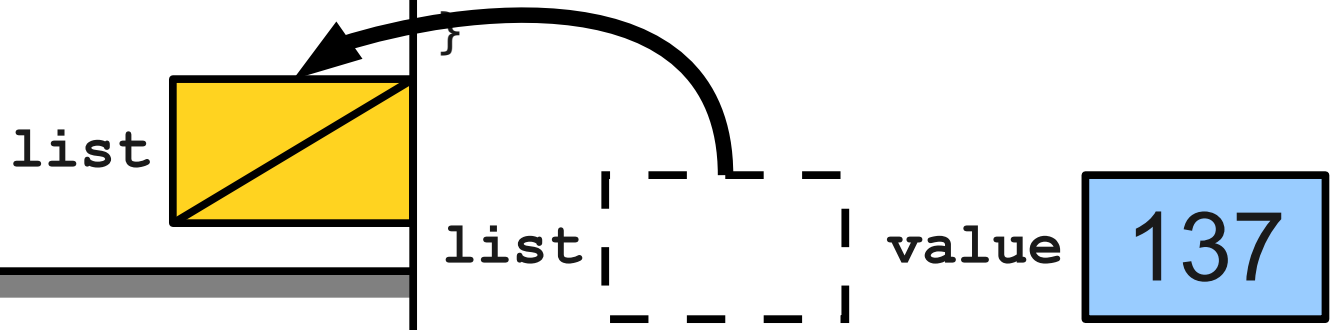

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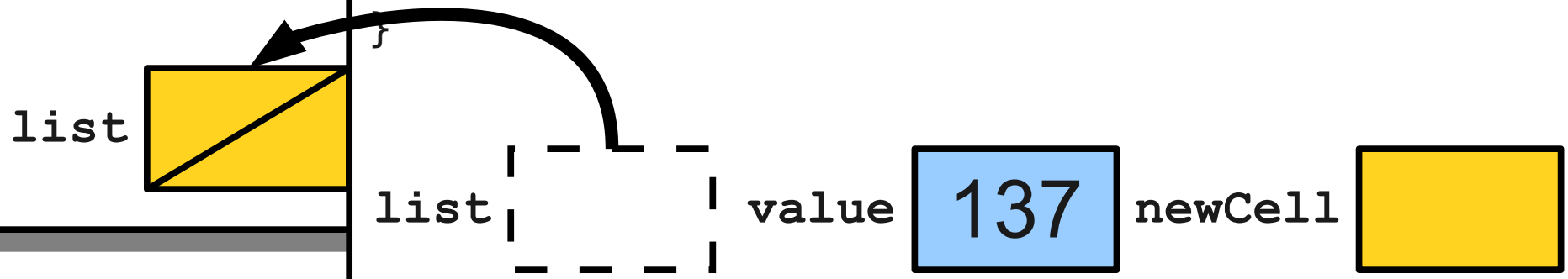

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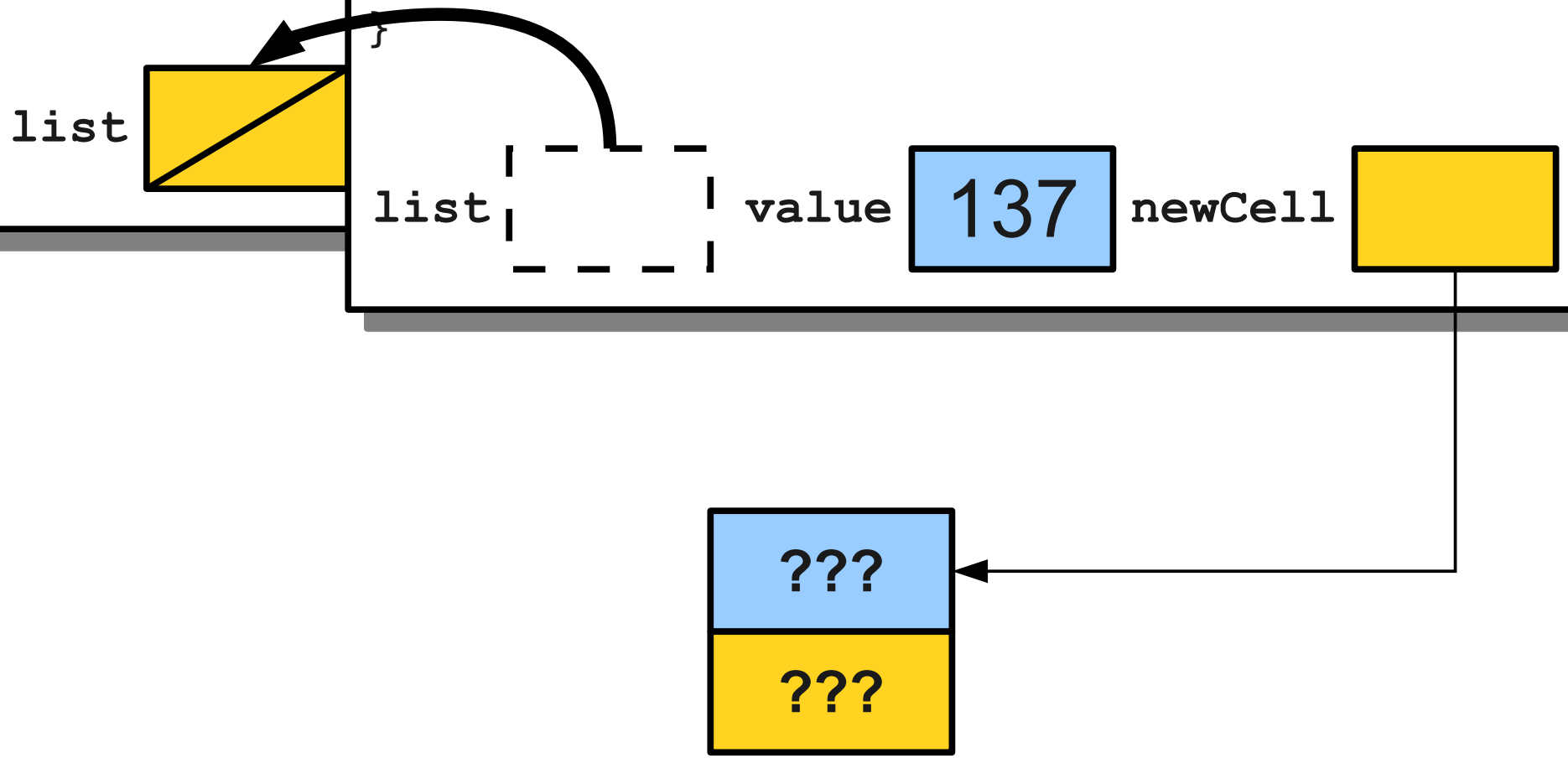

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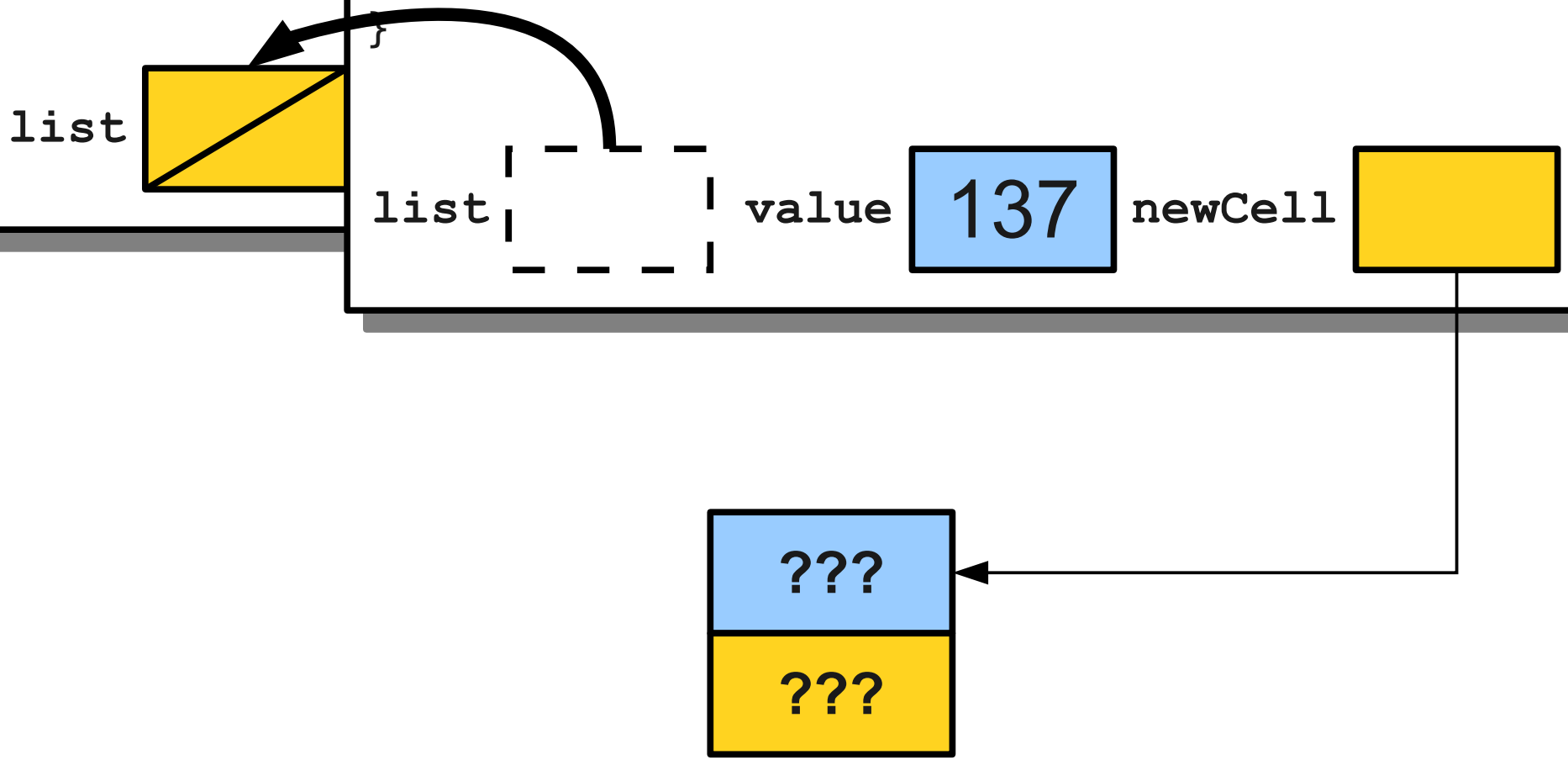

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int main() {
    Cell* list = N
    listInsert(lis
    listInsert(lis
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void listInsert(Cell*& list, int value) {
    Cell* newCell = new Cell;
    newCell->value = value;
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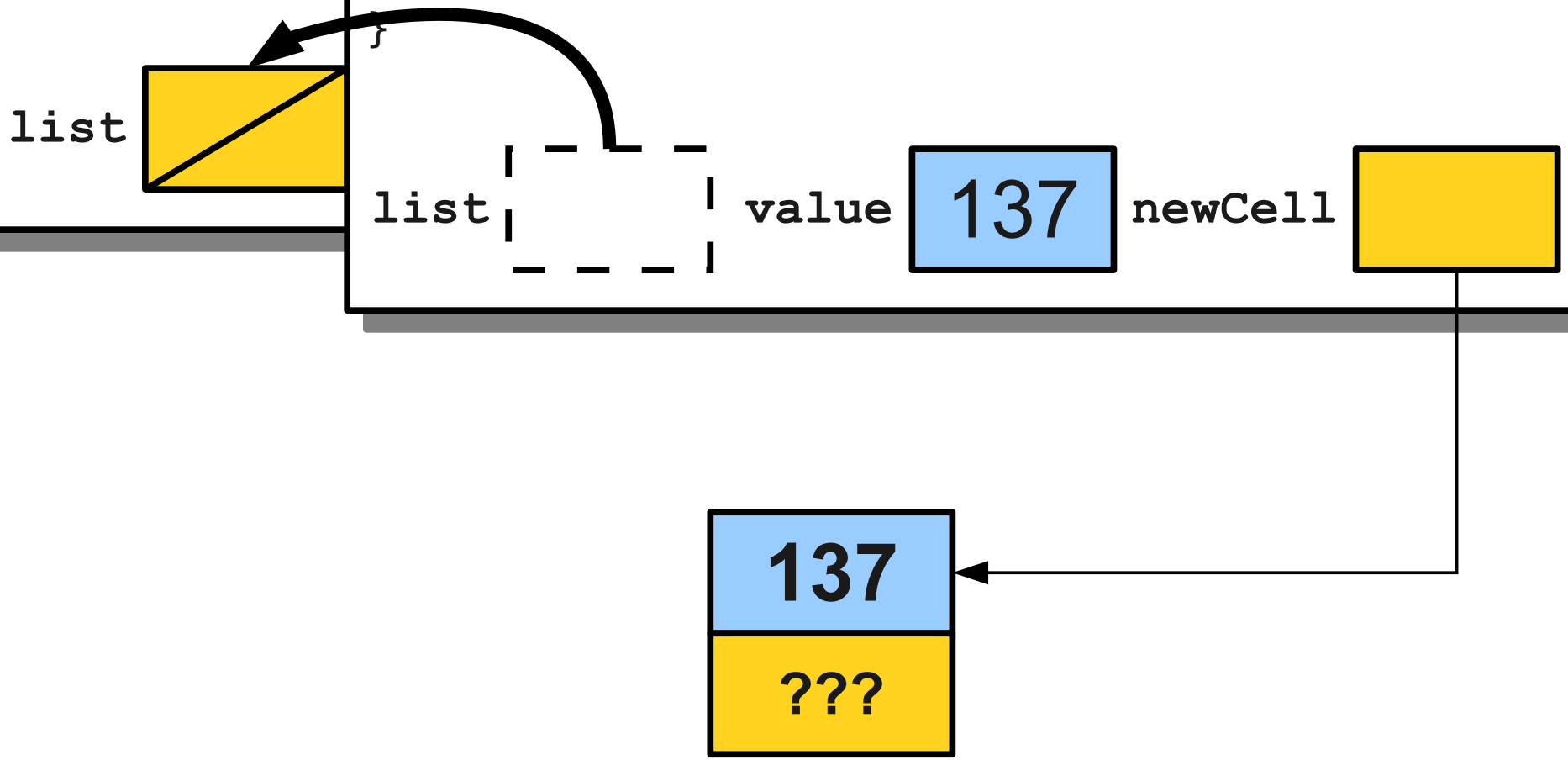

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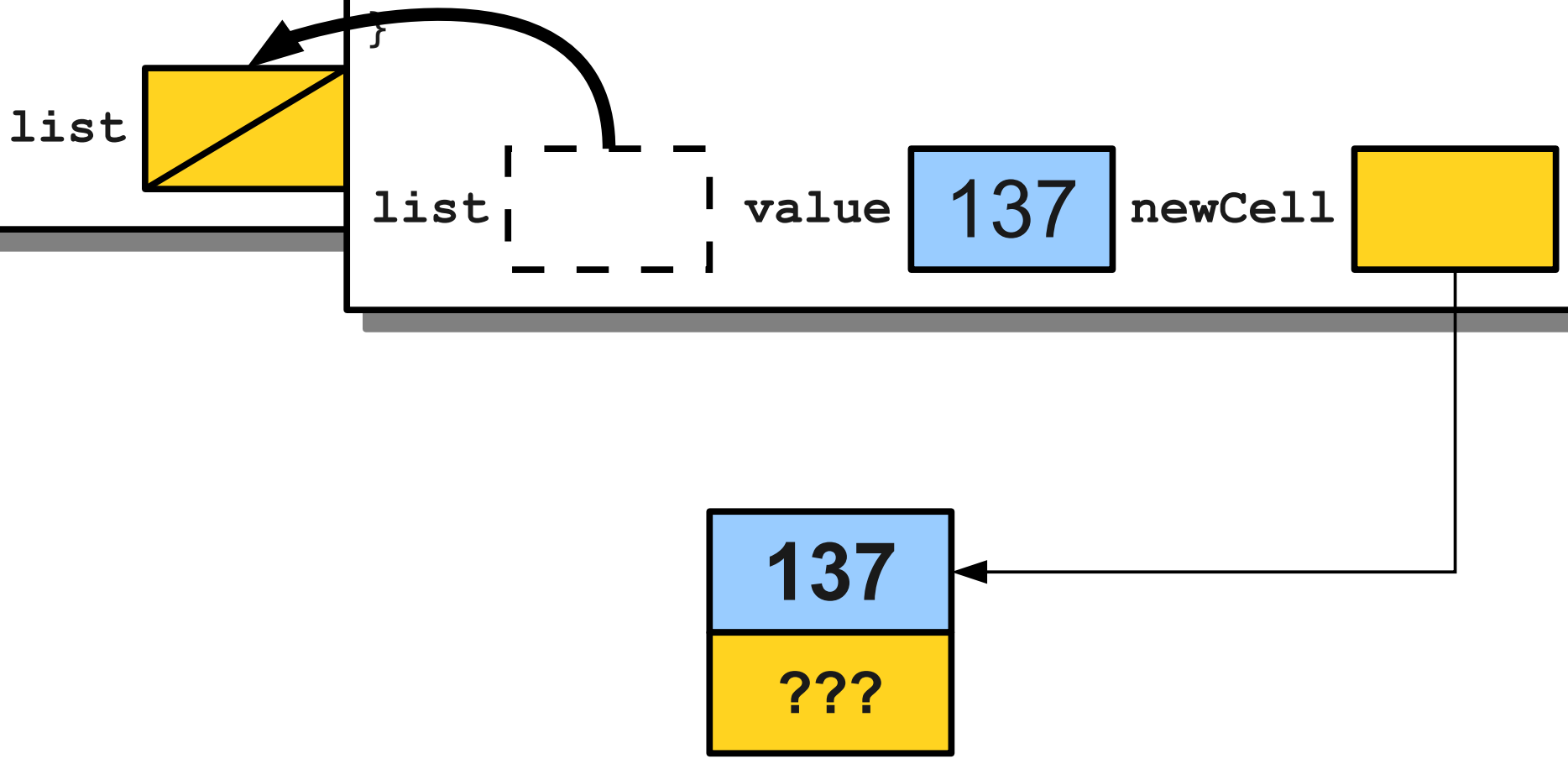

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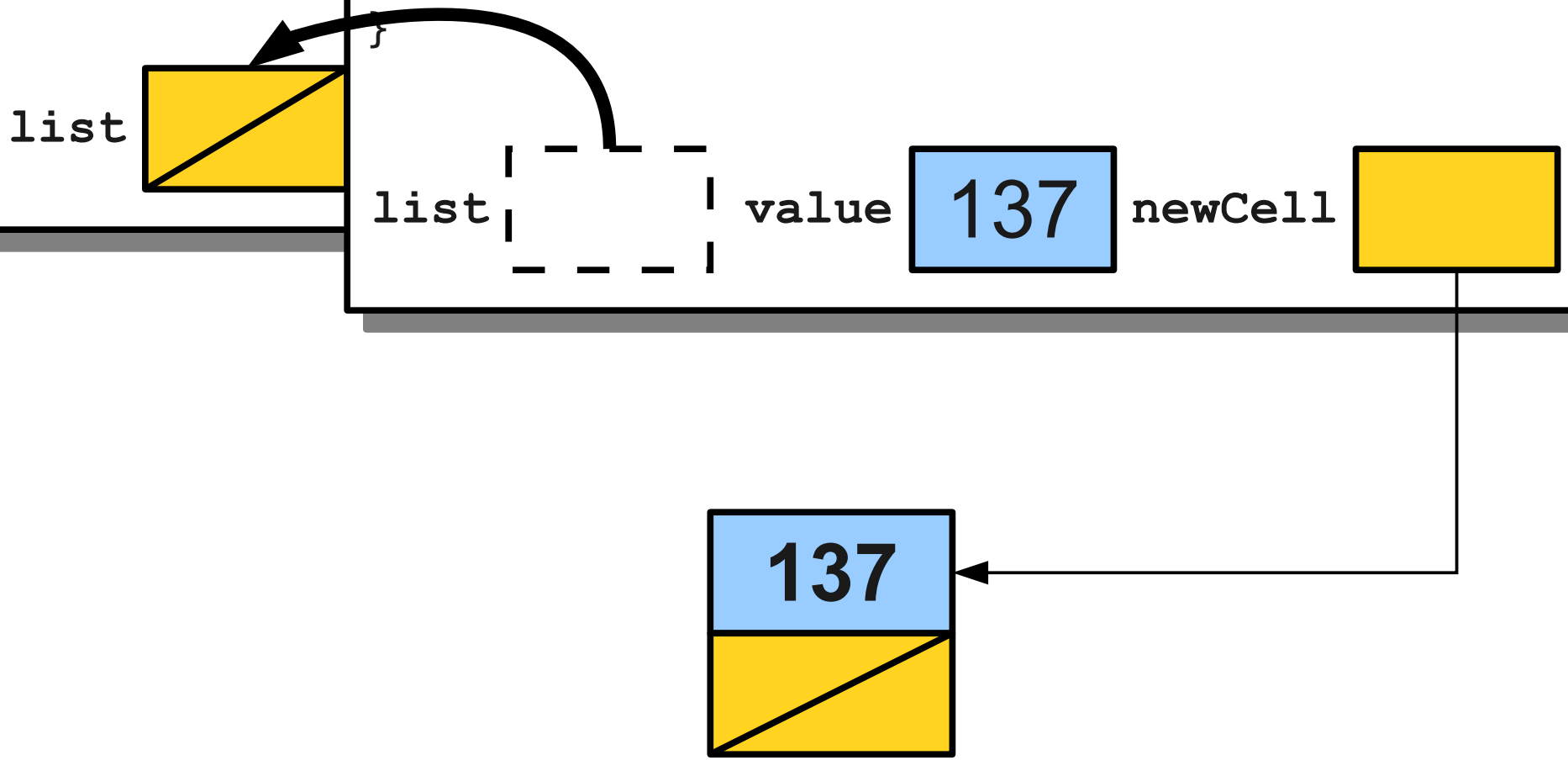

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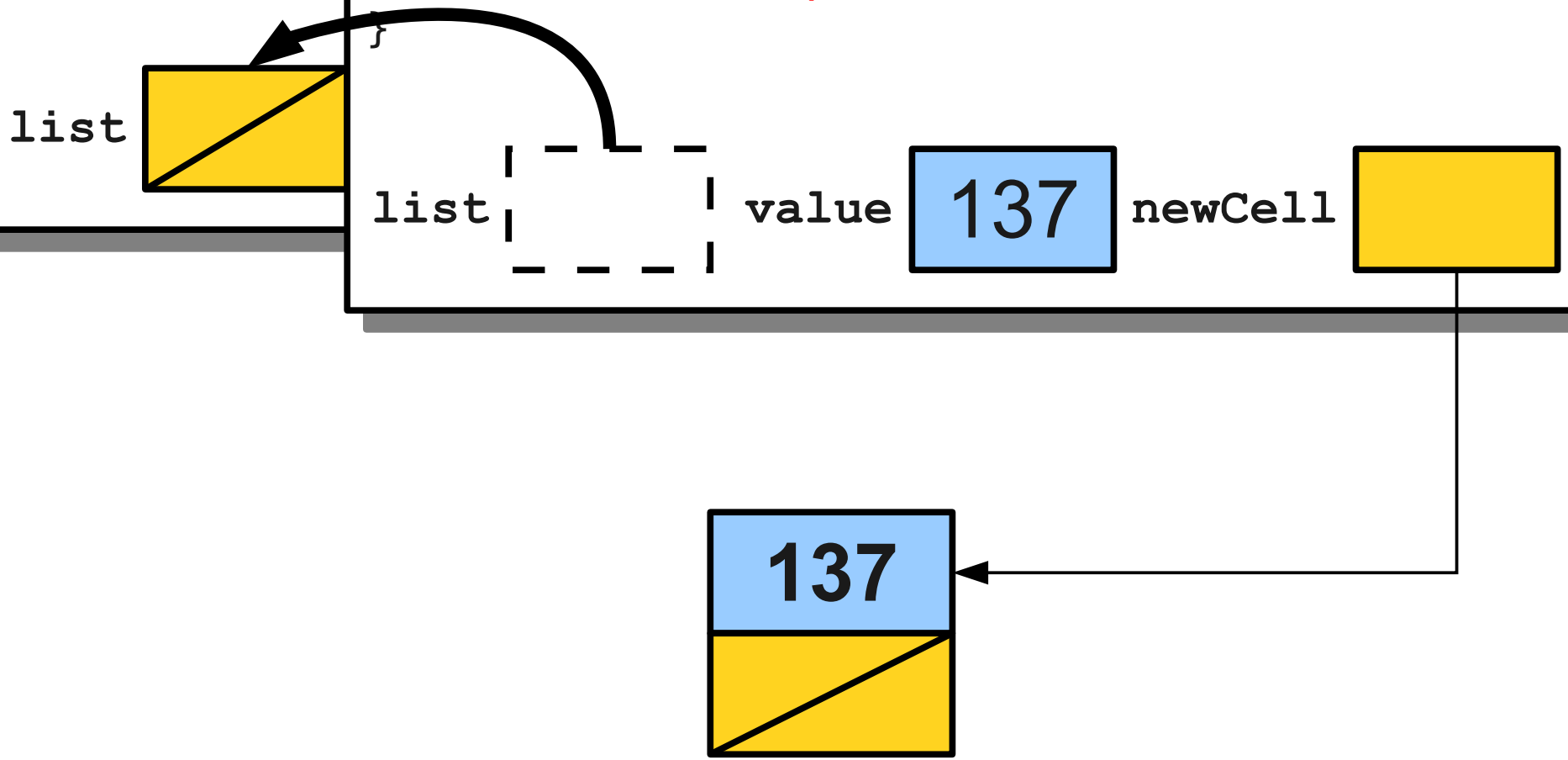

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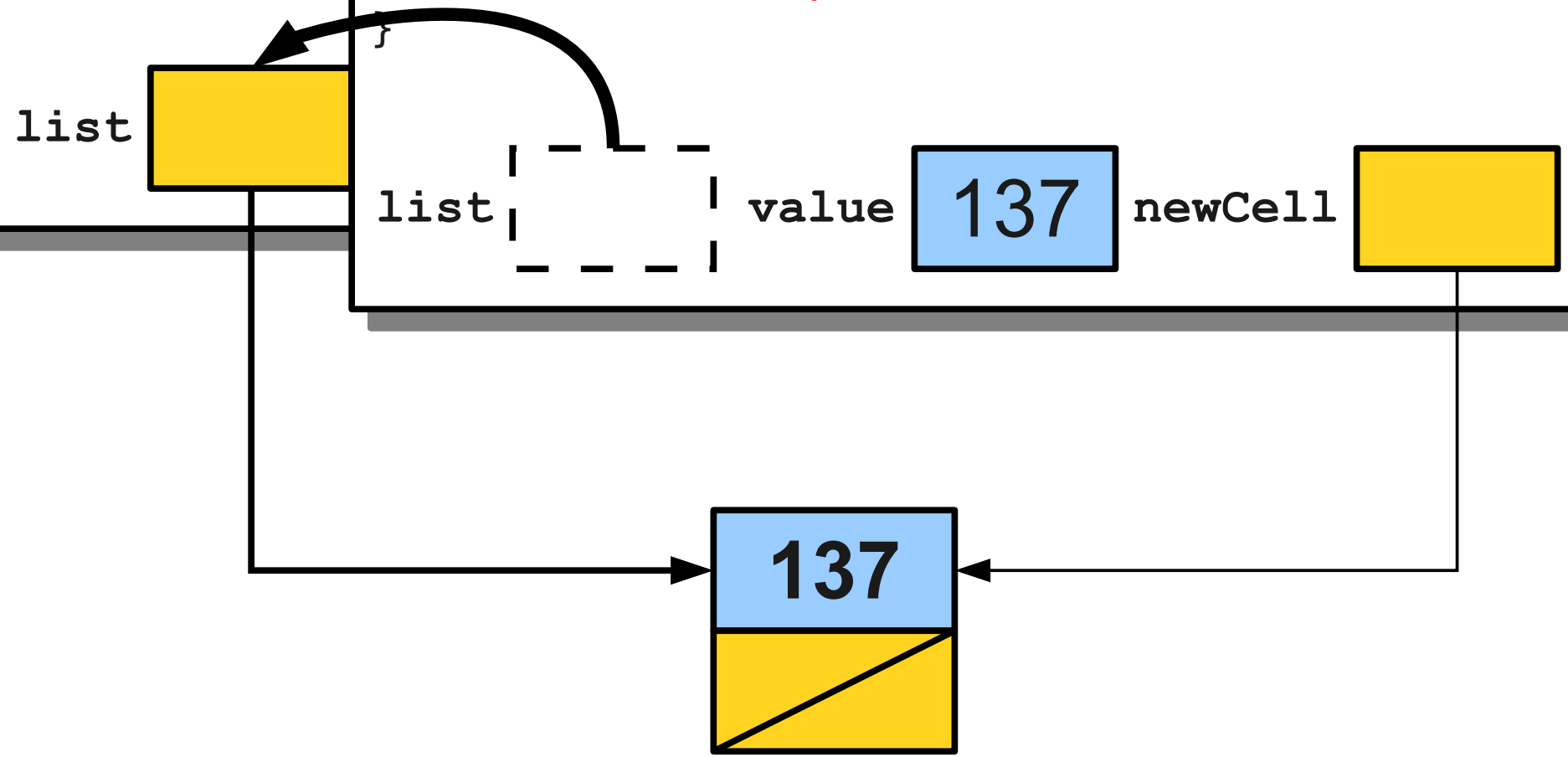
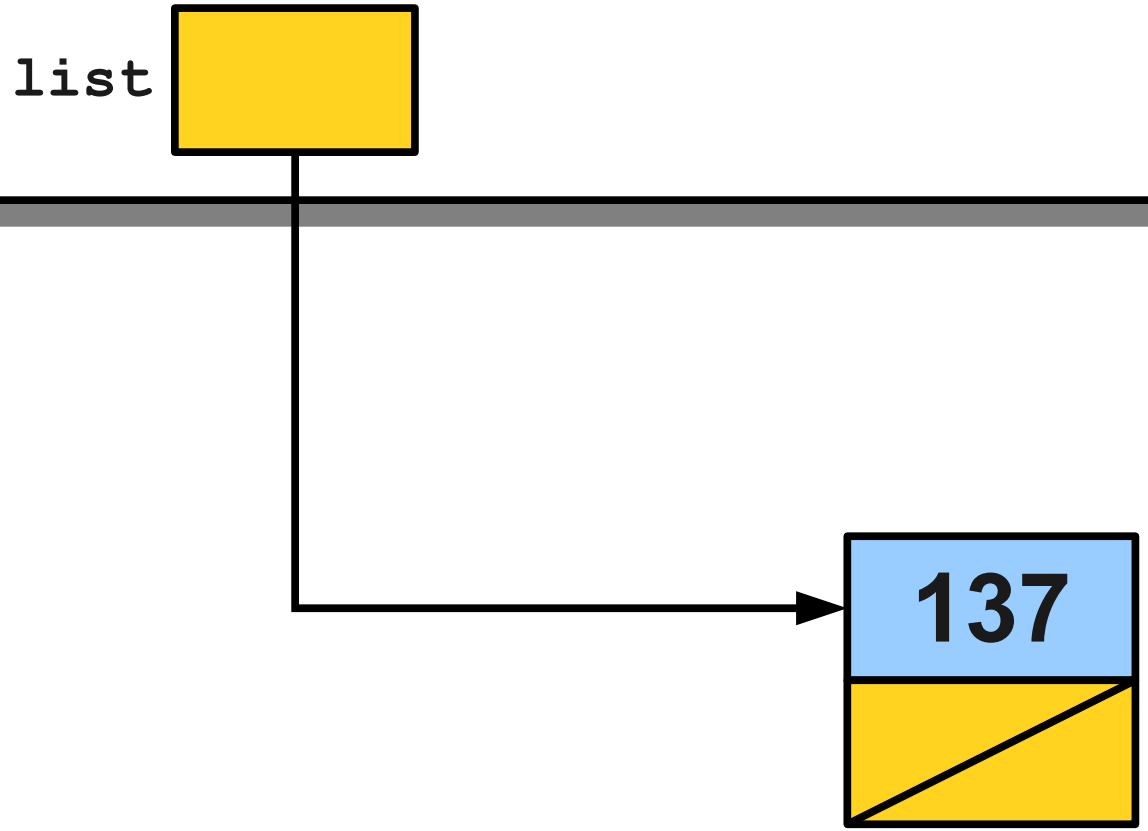


```
int main() {
    Cell* list = NULL;
    listInsert(list, 137);
    listInsert(list, 42);
    listInsert(list, 271);
}
```



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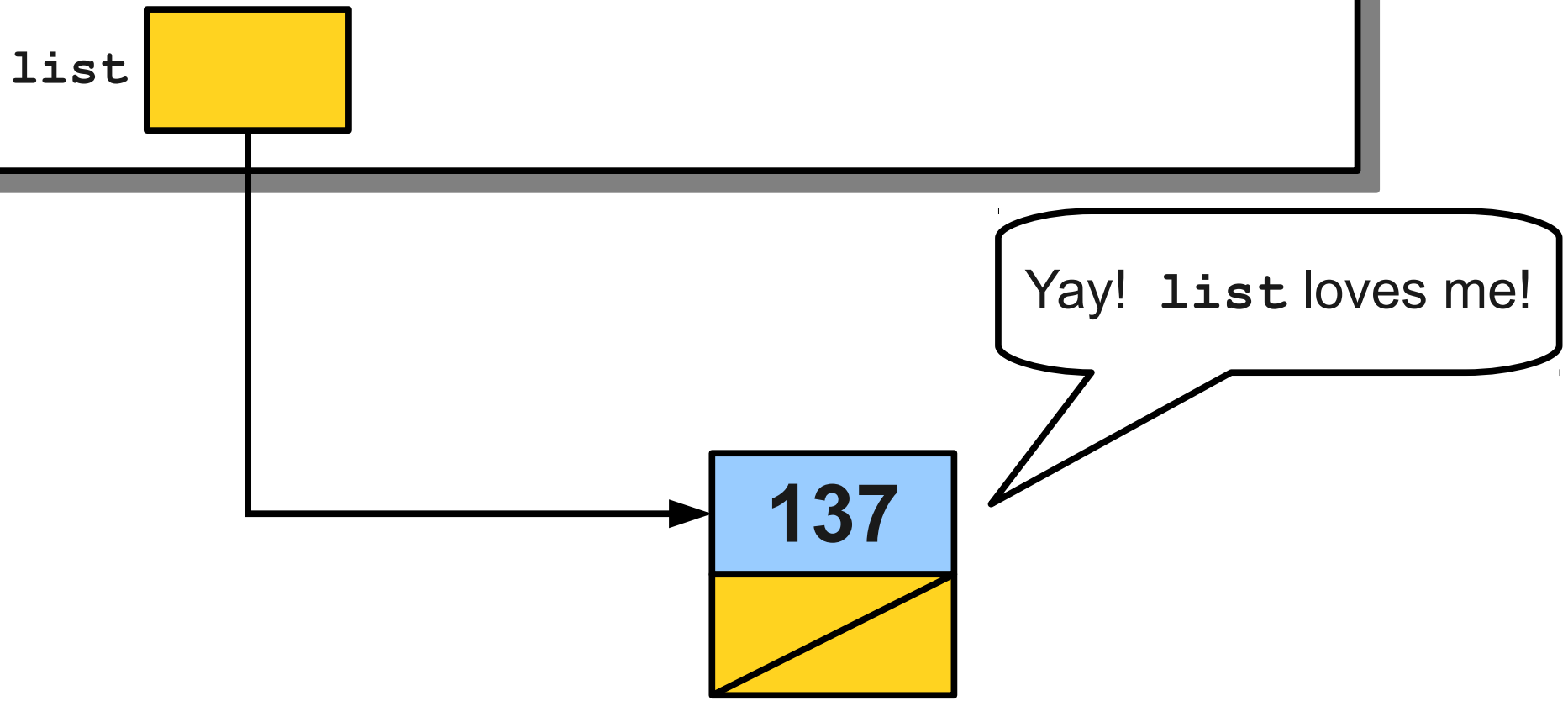

Pointers by Reference

- 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.

A Quick Interlude for Announcements

Apply to Section Lead!

http://cs198.stanford.edu

Announcements

- WiCS (Women in Computer Science) is holding a dessert night tonight!
- **6:30PM – 7:30PM** at the Gates Patio.
- RSVP:

  https://docs.google.com/forms/d/12hcDPU9FGxSOMoTfehGSvT57yUw_4dtV32ezYPlfkk4/viewform

Announcements

- Interested in applying engineering and technical skills to create social good? Attend the **Stanford4Good** Conference!
- This **Saturday, 11AM – 3PM** at the d.school.
- RSVP at http://bit.ly/Stanford4Good

Back to our regularly
scheduled programming...

Implementing `Queue`

- Earlier, we implemented a queue using two stacks.
- The implementation supported enqueue and dequeue in average-case O(1).
- We can also implement a queue using linked lists!
- Idea:
  - To **enqueue**, append a new cell to the end of the list.
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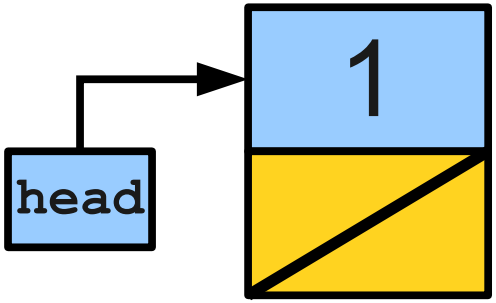

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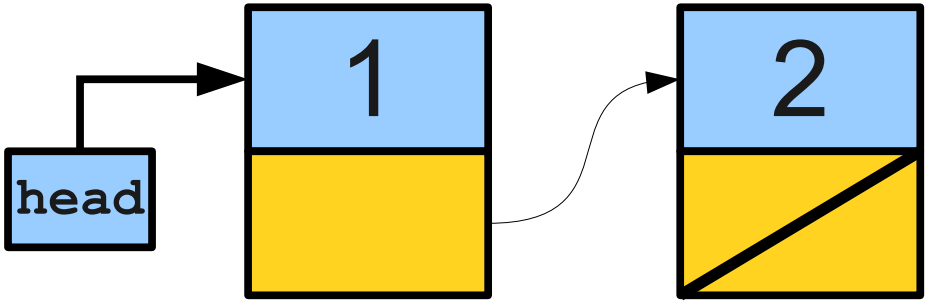

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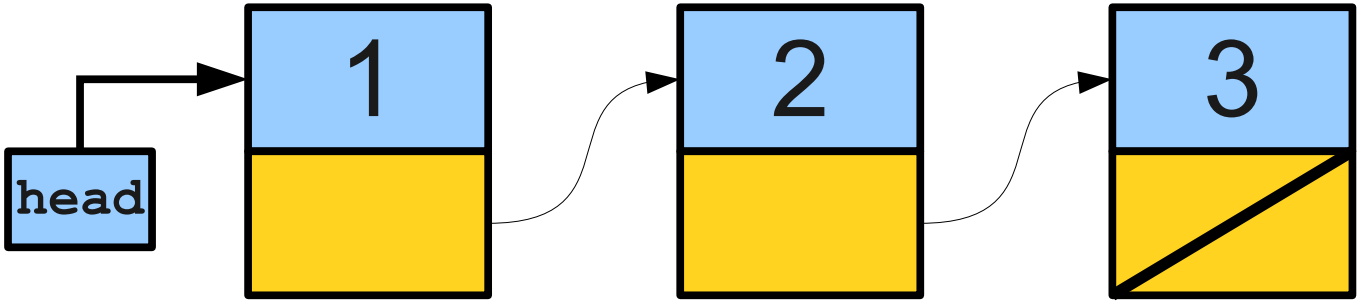

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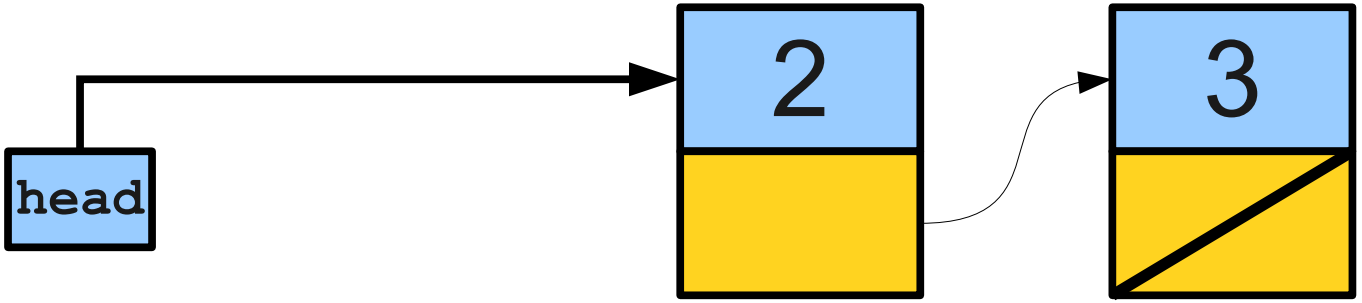

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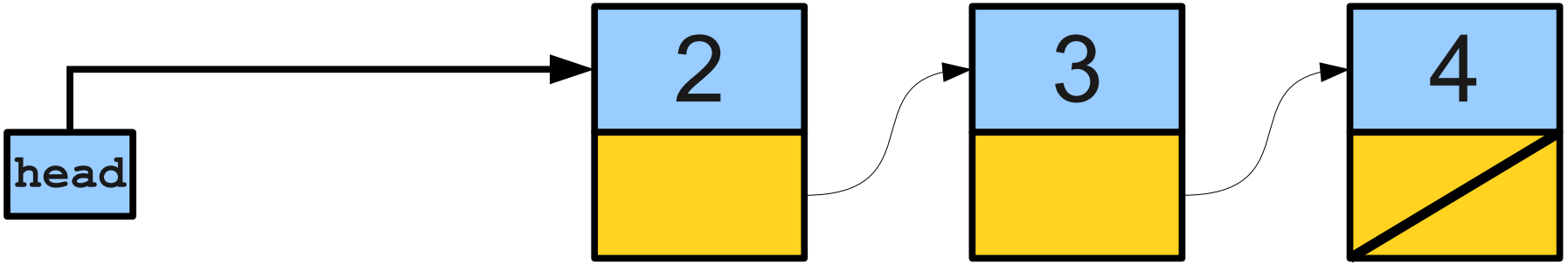

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A Surprising Fact

It is possible to build a **`Map`** that supports lookups that run, on average, in **O(1)** time.

How on earth is this possible?
Find out on Friday!