Containers

Part Two

Outline for Today

- ***Lexicon***
  - Storing a collection of words.
- ***Set***
  - Storing a group of whatever you'd like.
- ***Map***
  - A powerful, fundamental container.

Lexicon

Lexicon

- A **`Lexicon`** is a container that stores a collection of words.
- The `Lexicon` is designed to answer the following question efficiently:

  Given a word, is it contained in the `Lexicon`?

- The `Lexicon` does *not* support access by index. You can't, for example, ask what the 137th English word is.
- However, it *does* support questions of the form "does this word exist?" or "do any words have this as a prefix?"

Tautonyms

- A ***tautonym*** is a word formed by repeating the same string twice.
  - For example: murmur, couscous, papa, etc.
- What English words are tautonyms?

Some Aa

http://upload.wikimedia.org/wikipedia/commons/f/f1/Aa_large.jpg

One Bulbul

More than One Caracara

http://www.greglasley.net/images/CO/Crested-Caracara-F3.jpg

Introducing the Dikdik

And a Music Recommendation

Time-Out for Announcements!

Sections

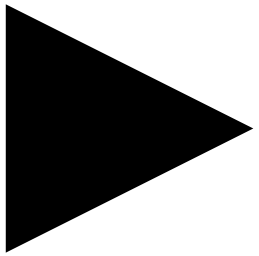
- Discussion sections start this week!
  - Didn’t sign up for a section? You can sign up for any section that has an open slot by visiting the CS198 website (cs198.stanford.edu).
  - If your section time doesn’t work for you, you can also switch into any section with available space. Visit cs198.stanford.edu to do this.
- ***Reminder:*** Section attendance and participation forms part of your course grade. (Also, if you don’t have a section, none of your work will be graded!)
- ***Reminder:*** We don’t look to Axess enrollments; you need to have a section assigned through our system.

Late Policy

- Everyone has four free “late days” that can be used to extend assignment deadlines.
- Each late day grants an automagic 24-hour extension on an assignment.
- You can use at most two late days per assignment; nothing will be accepted more than 48 hours after the normal deadline.
- Check the syllabus for more information.

Assignment Grading

- Your coding assignments are graded on both functionality and on coding style.
- The ***functionality score*** is based on correctness.
  - Do your programs produce the correct output?
  - Do they work on all inputs?
  - etc.
- The ***style score*** is based on how well your program is written.
  - Are your programs well-structured?
  - Do you decompose problems into smaller pieces?
  - Do you use variable naming conventions consistently?
  - etc.
- We have a style guide up the course website, as well as a pre-submit checklist to make sure everything is ready to go before you formally submit. Check these out – they're very useful!



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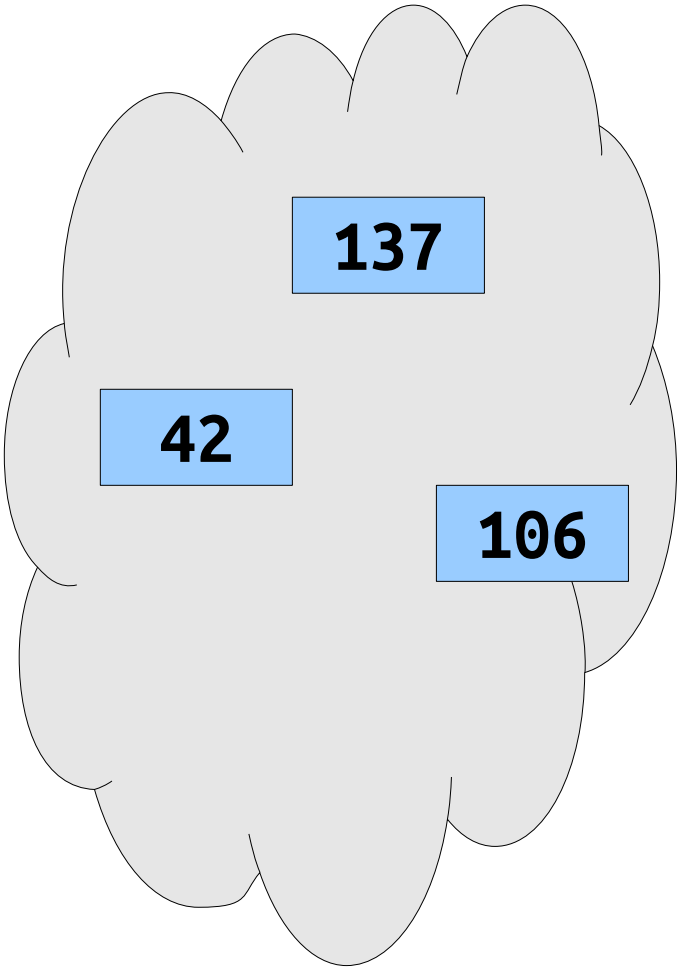

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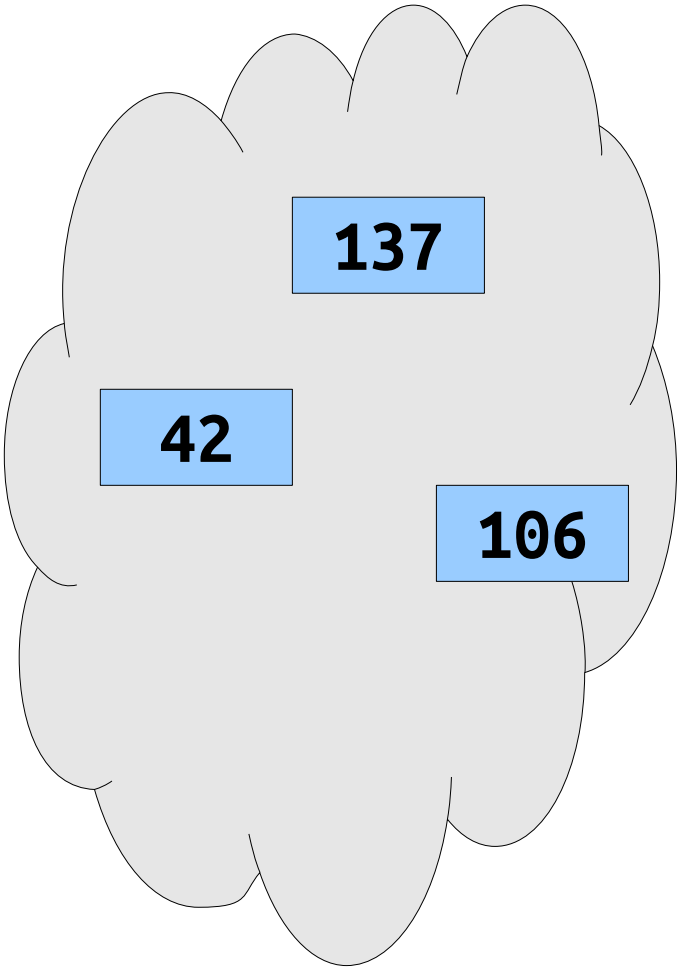

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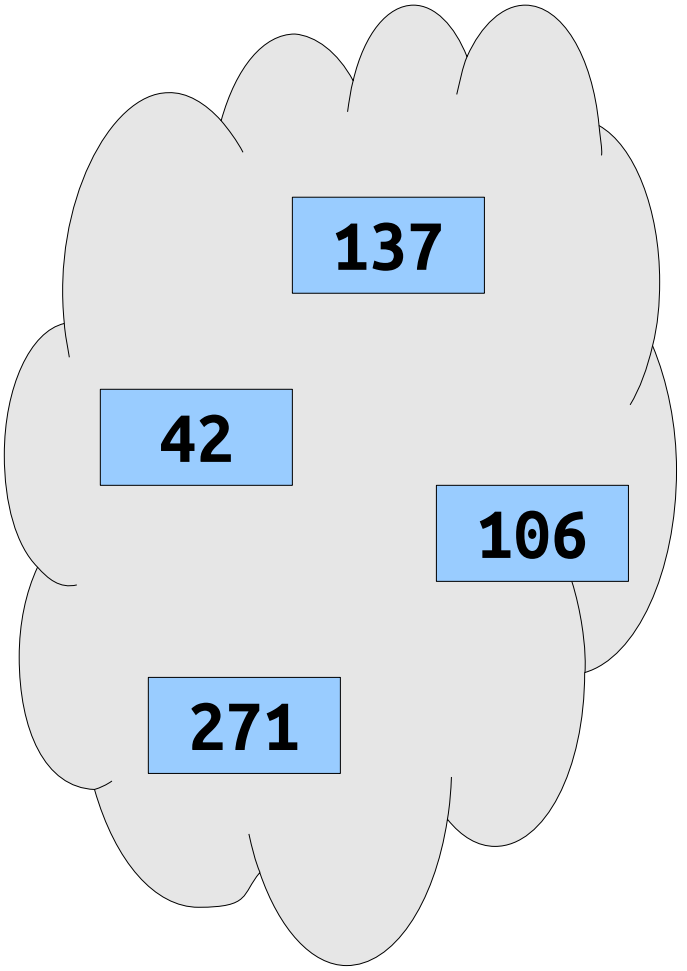

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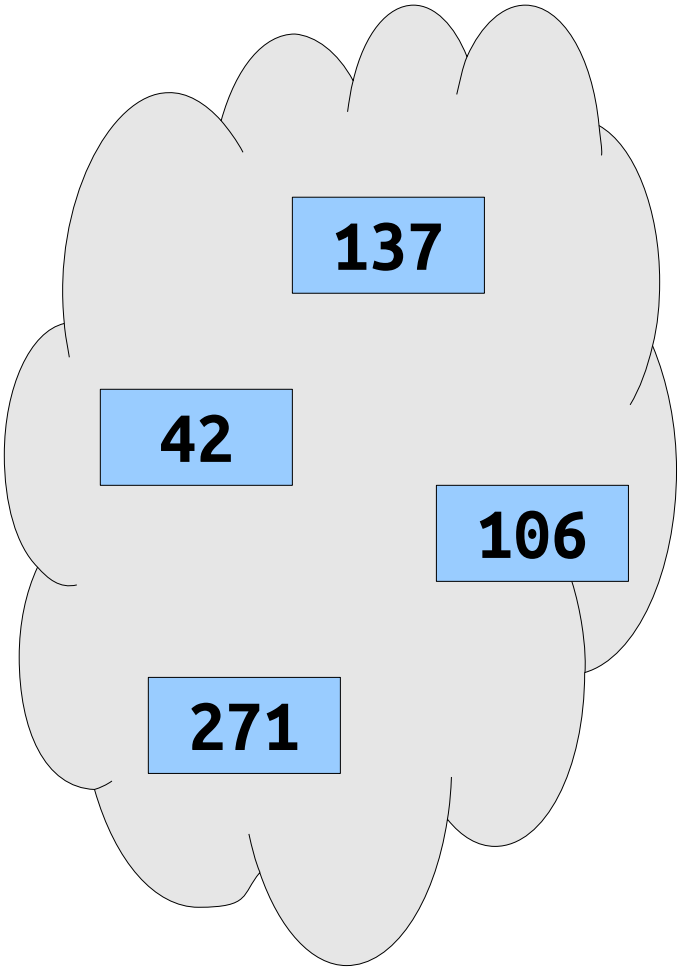

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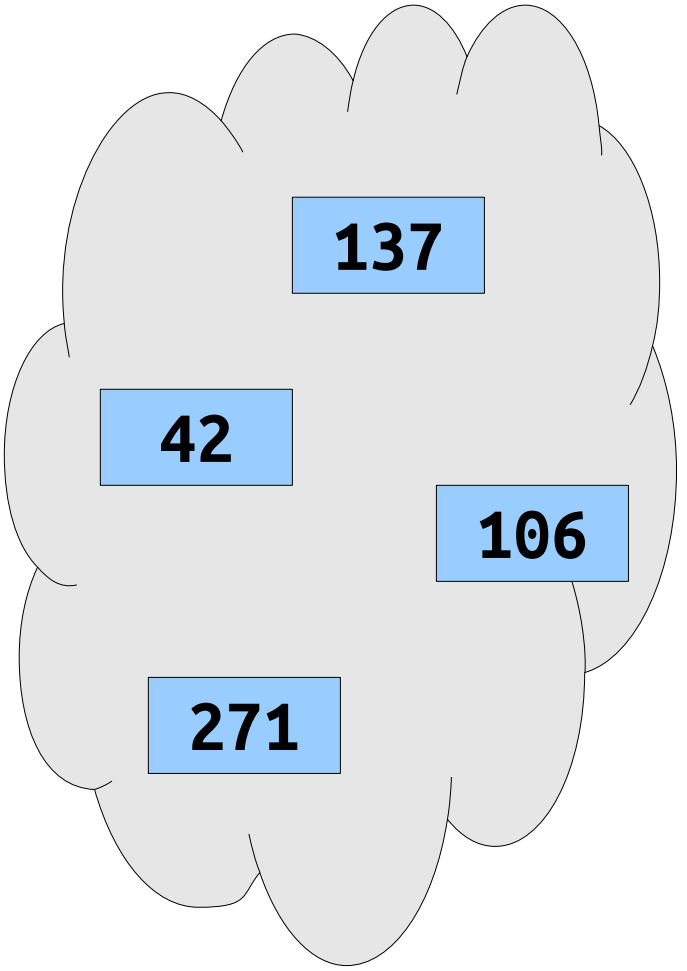

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values -= 106;
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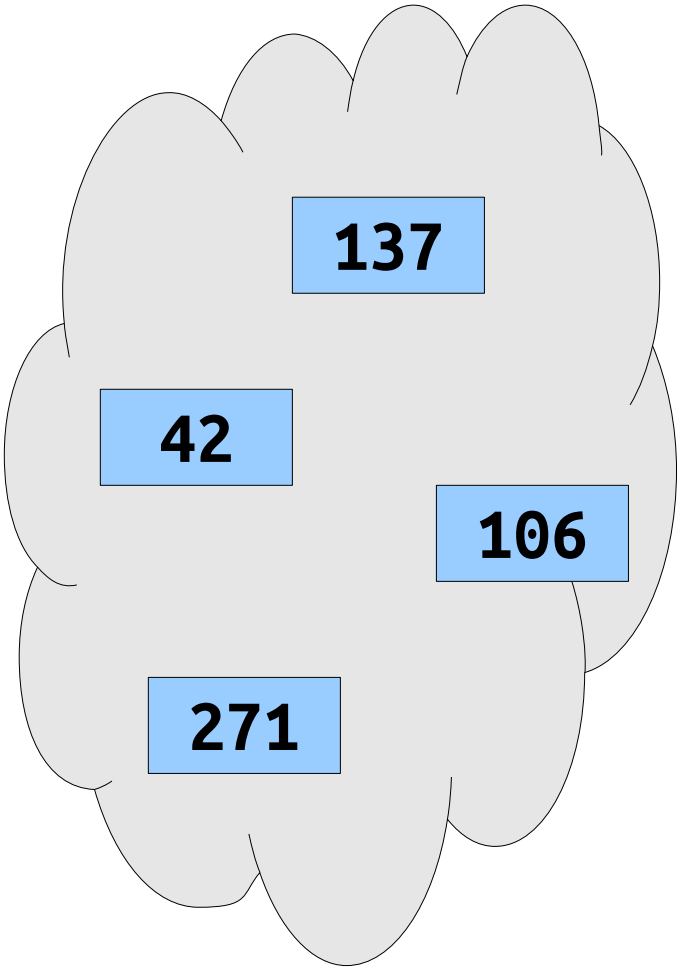

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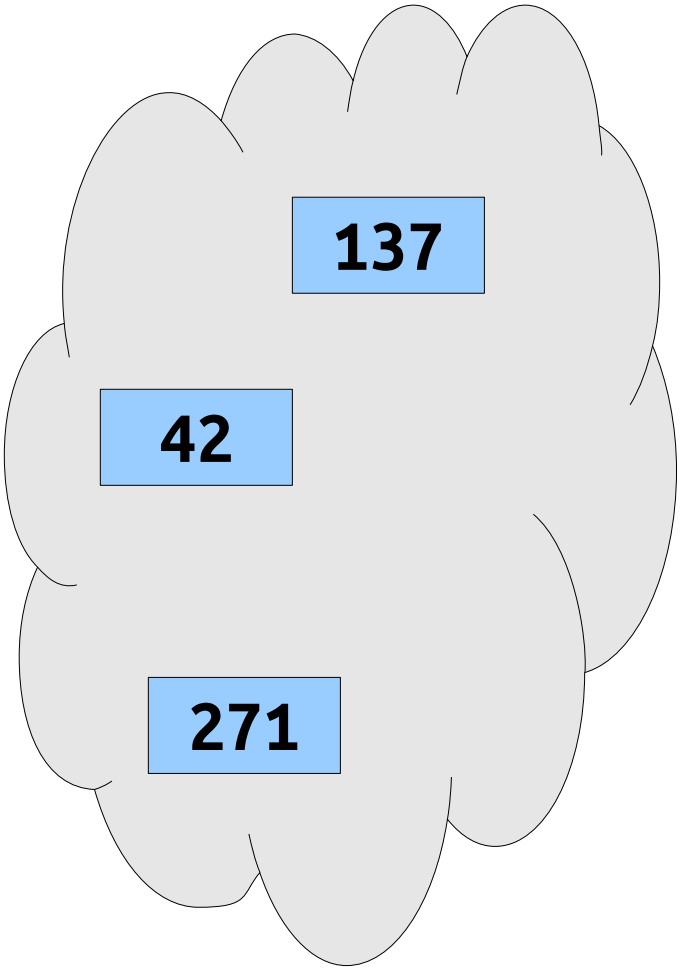

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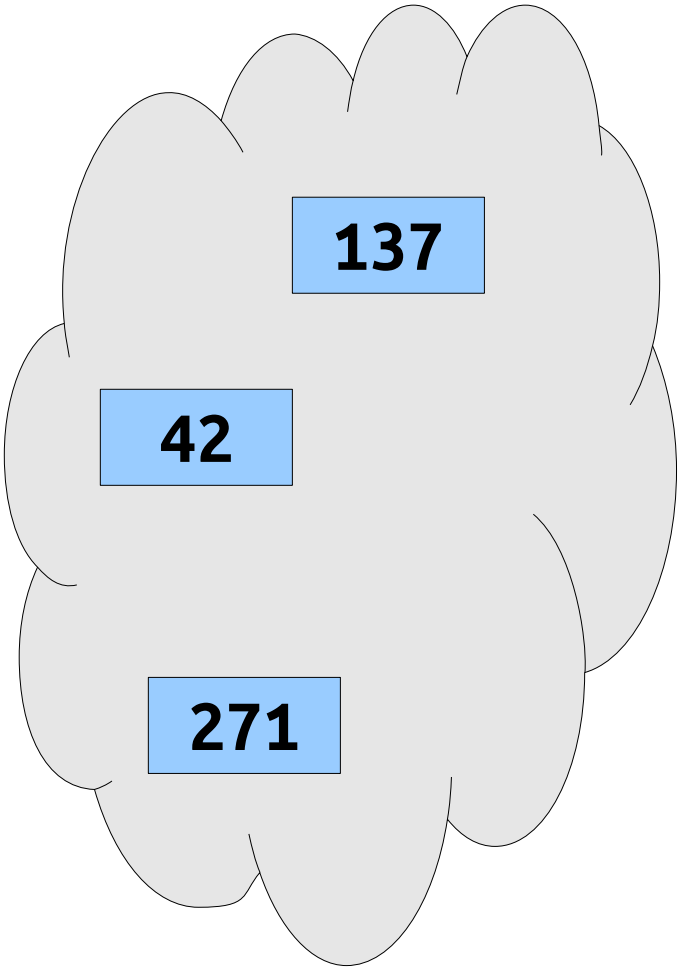


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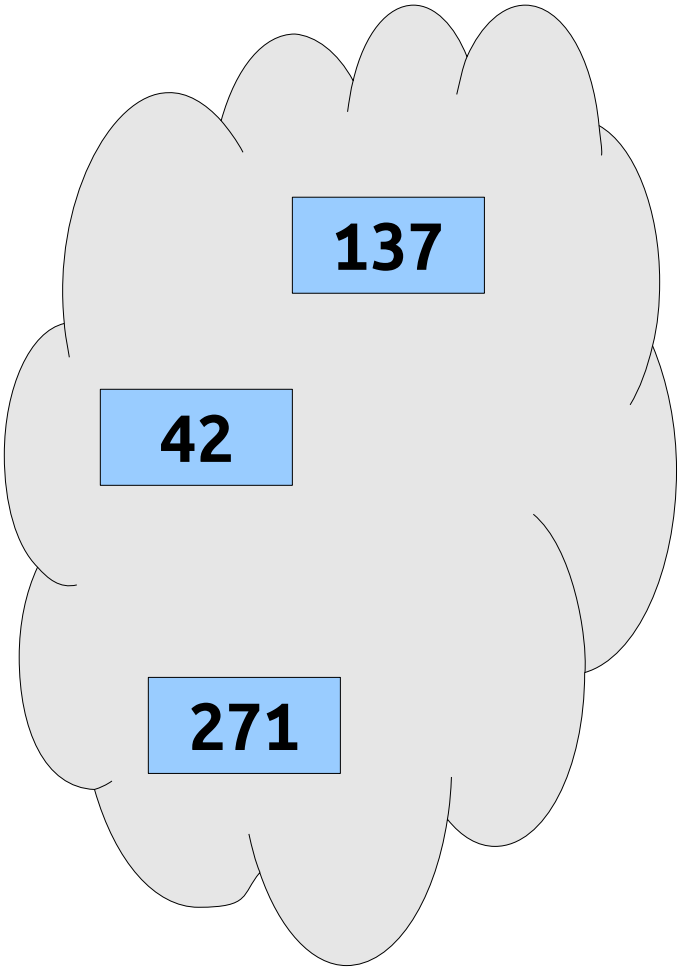


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values += 271;
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values -= 106;
values -= 103; // Has no effect
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- The `Set` represents an unordered collection of distinct elements.
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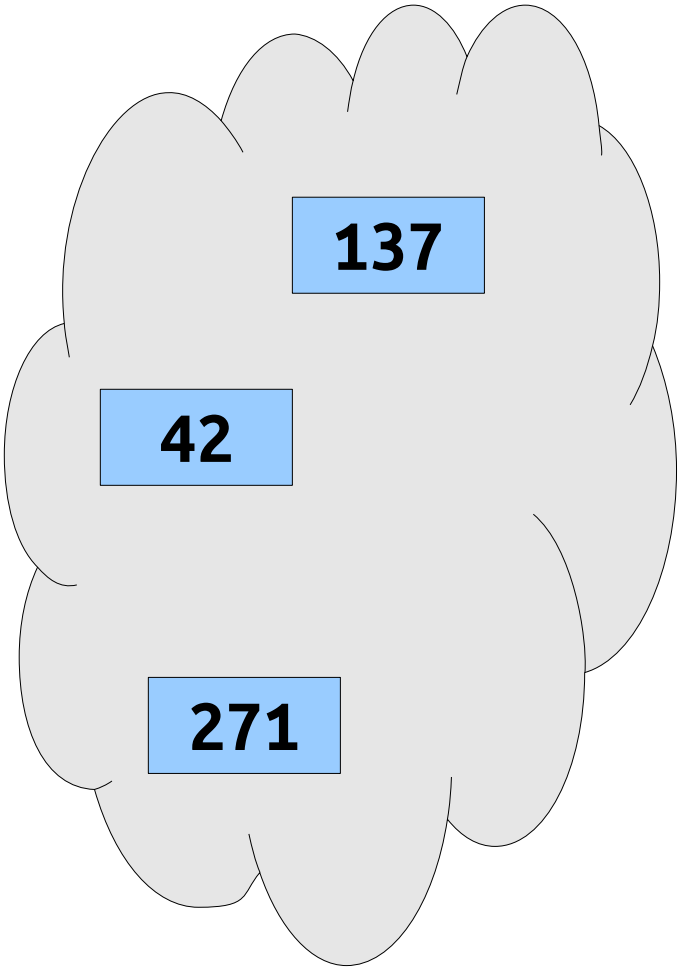
- You may find it helpful to interpret += as "ensure this item is there" and -= as "ensure this item isn't there."



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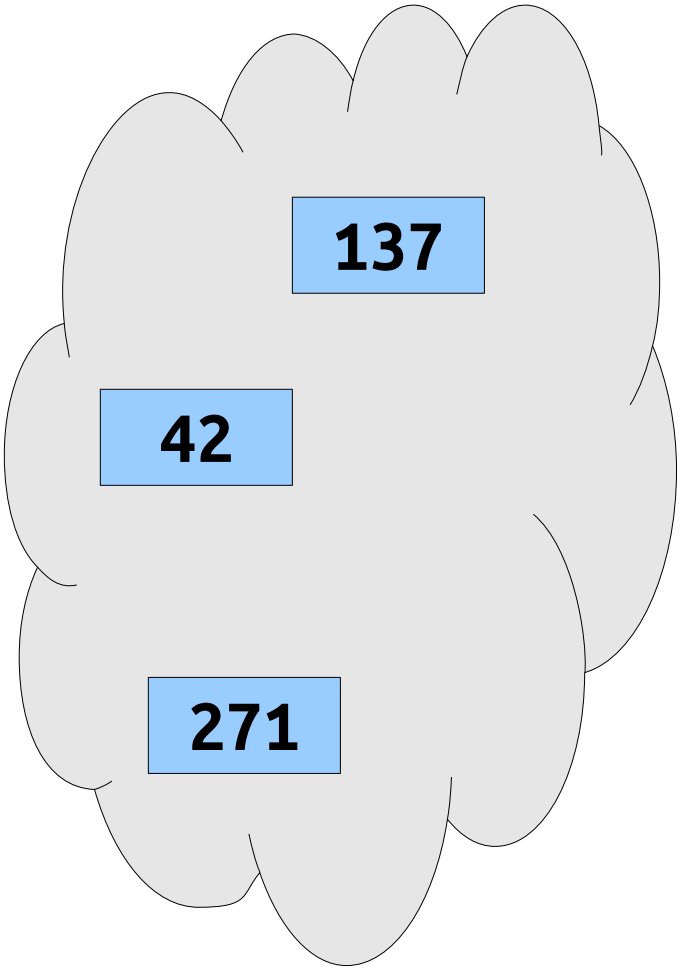

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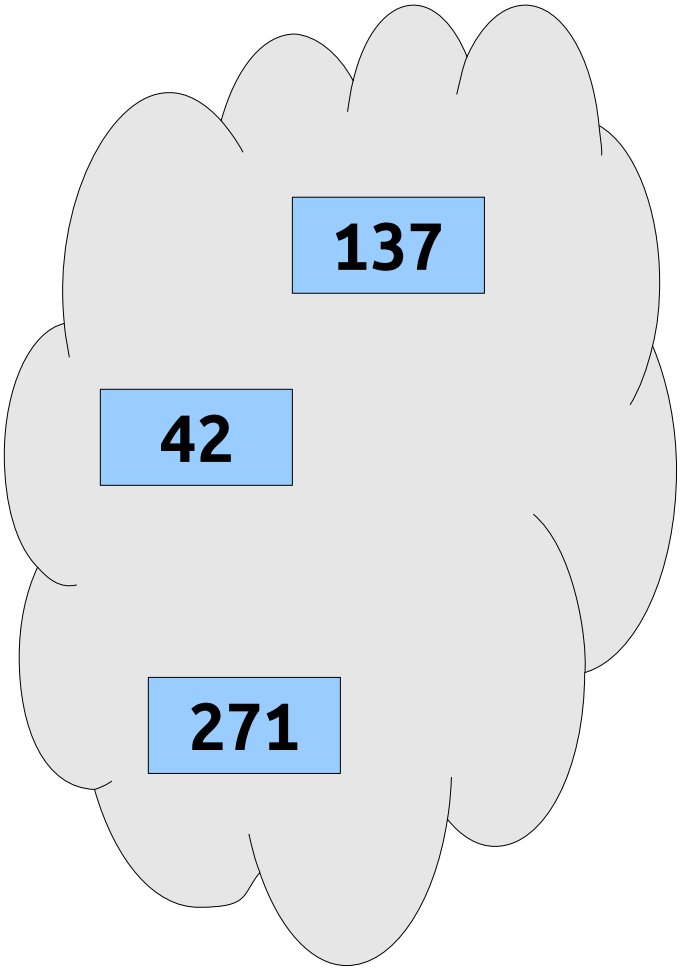


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if (values.contains(137)) {
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- You can loop over the contents of a set with a range-based `for` loop.

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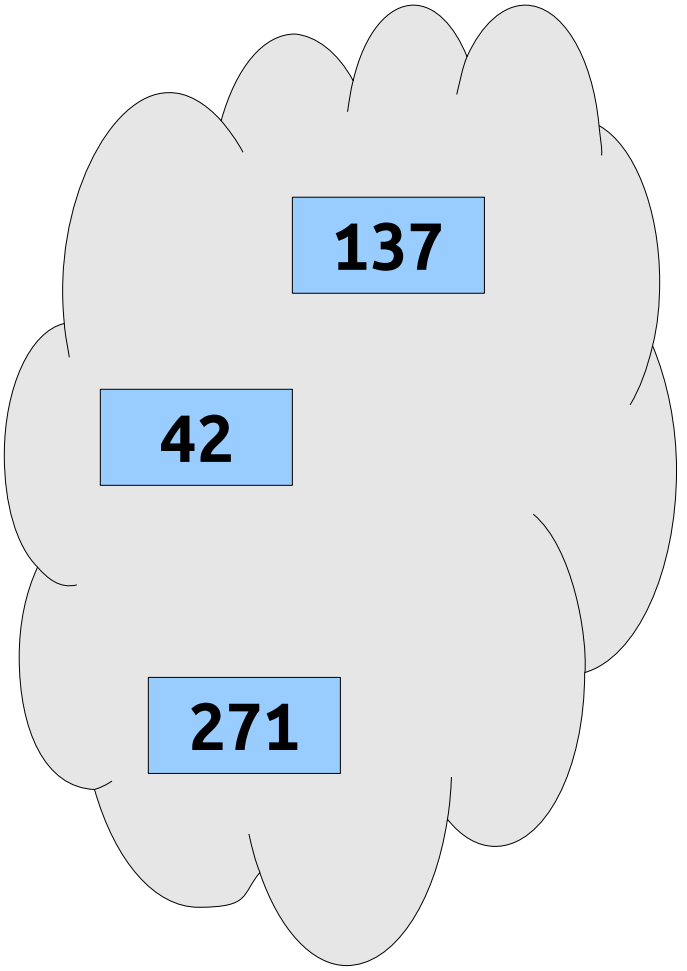

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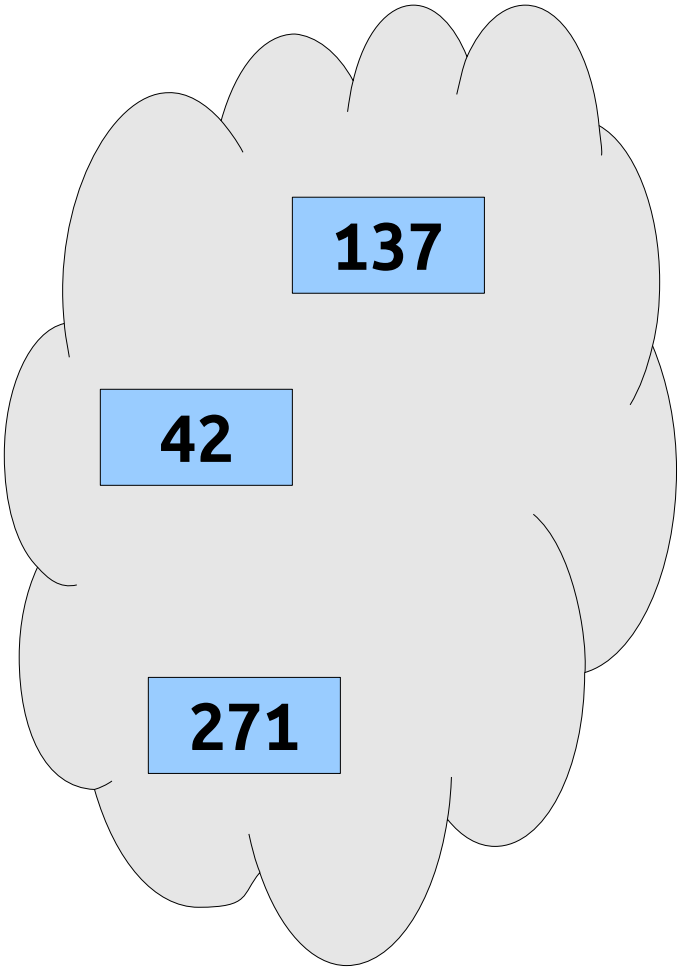


```
if (values.contains(137)) {
    cout << "<(^_^)>" << endl;
}

for (int value: values) {
    cout << value << endl;
}
```

Operations on `Sets`

- You can add a value to a `Set` by writing

set `+=` ***value***`;`

- You can remove a value from a `Set` by writing

set `-=` ***value***`;`

- You can check if a value exists in a `Set` by writing

set`.contains(`***value***`)`

- Many more operations are available (union, intersection, difference, subset, etc.). Check the Stanford C++ Library Reference guide for details!

Application: Word Economy

- Some long words are use few distinct letters.
  - “caracara” has length eight, but only uses the letters c, r, and a.
- The ***character efficiency*** of a word is the ratio of its length to the number of different letters it contains.
  - “caracara” has efficiency $^{8}/_{3} \approx 2.67$.
- What is the highest-efficiency English word?

Map

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  - It's analogous to `dict` in Python, to `Map` in Java, and to objects (used as key/value stores) in JavaScript.
- Each key is associated with a value.

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Map<string, int> heights;

heights["Serbia"] = 153;
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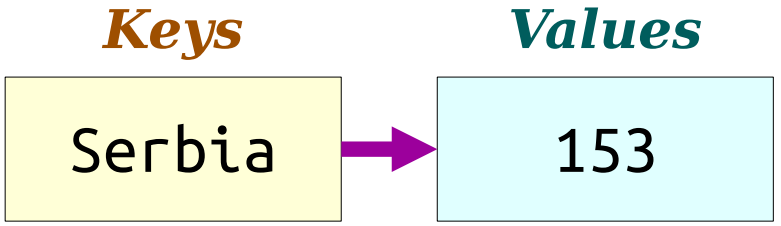


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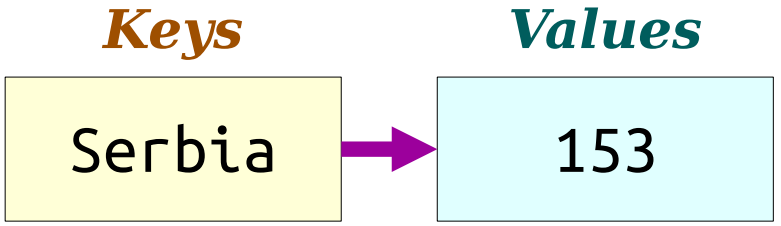


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Map<string, int> heights;

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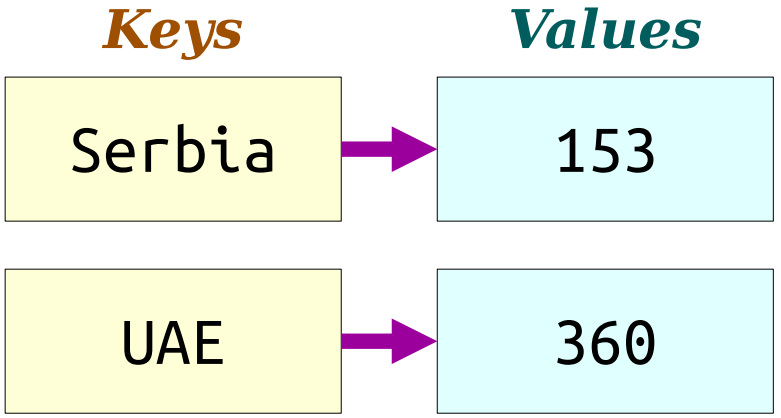


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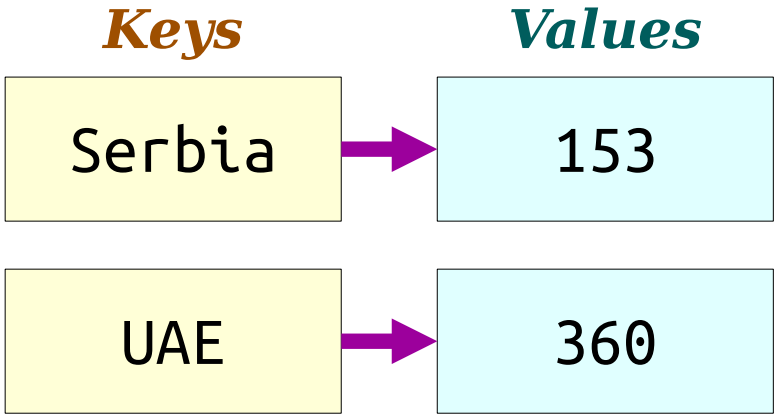


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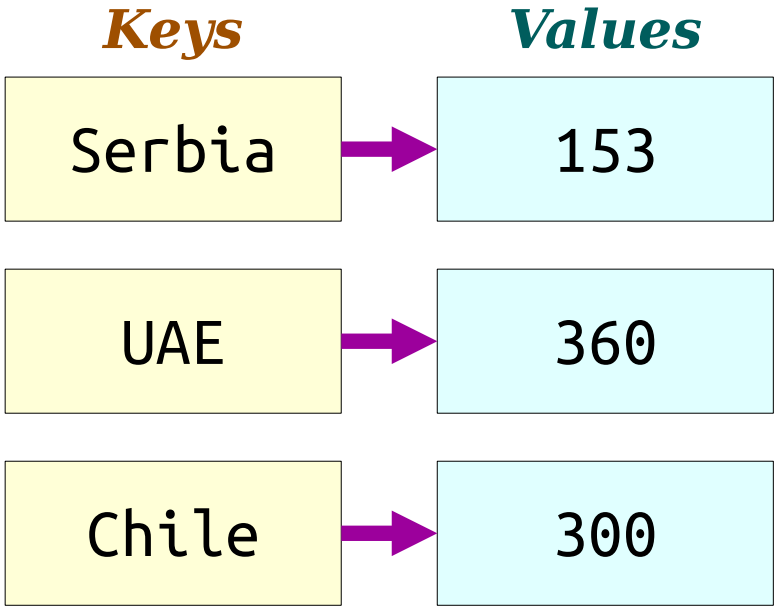


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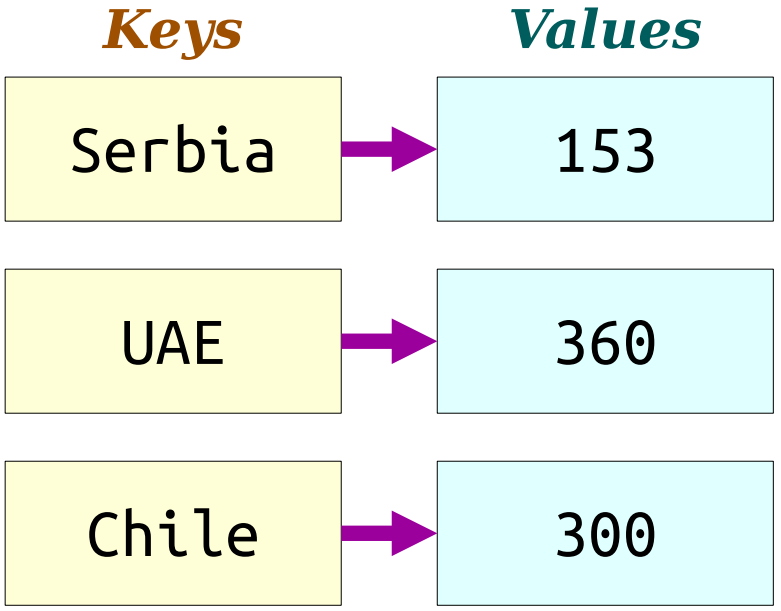


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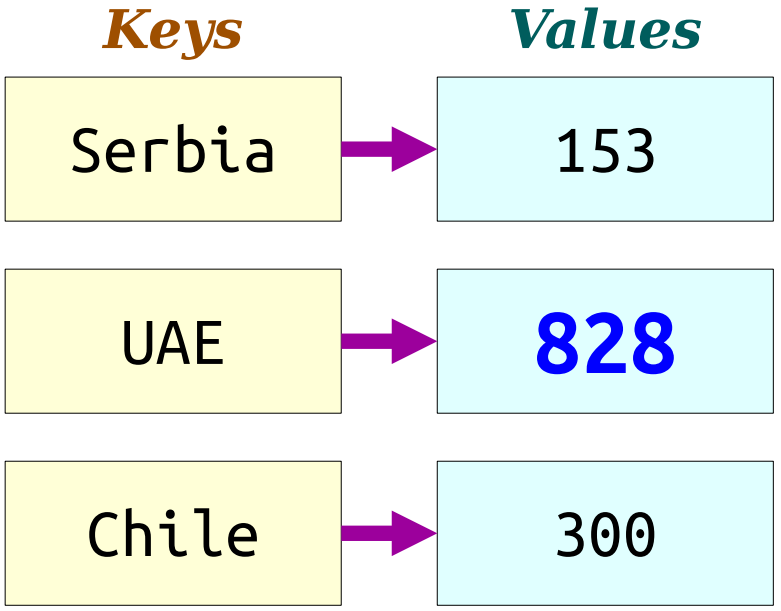


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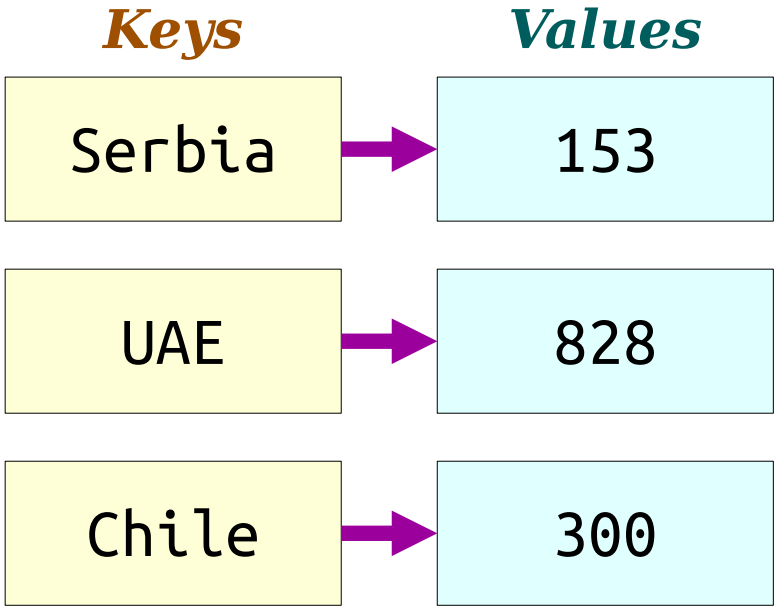


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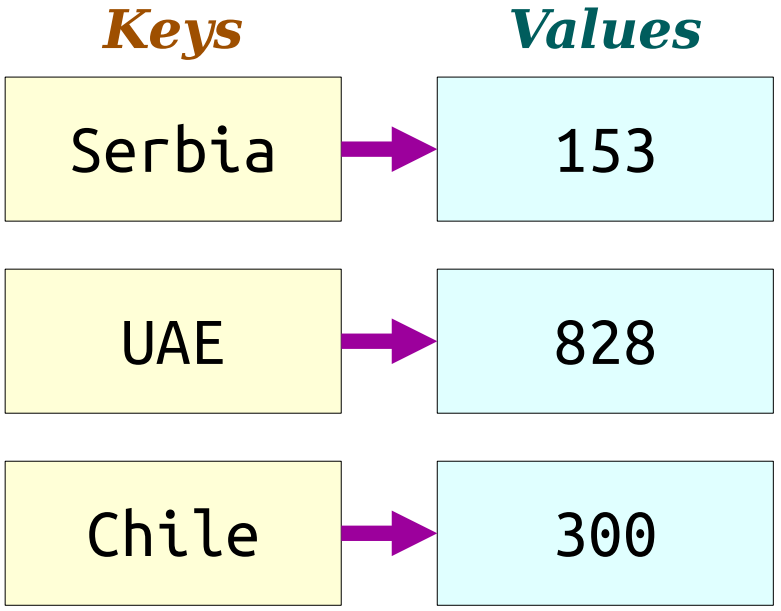


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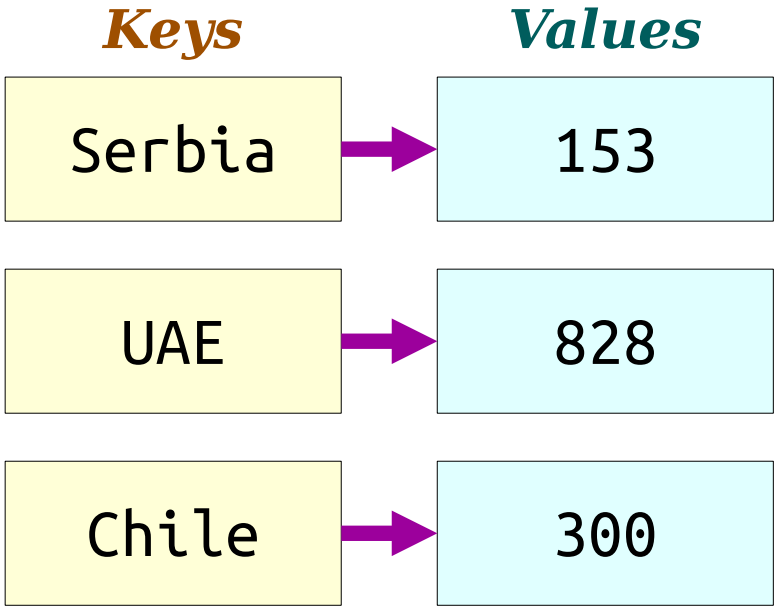


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cout << heights["Chile"] << endl;
```

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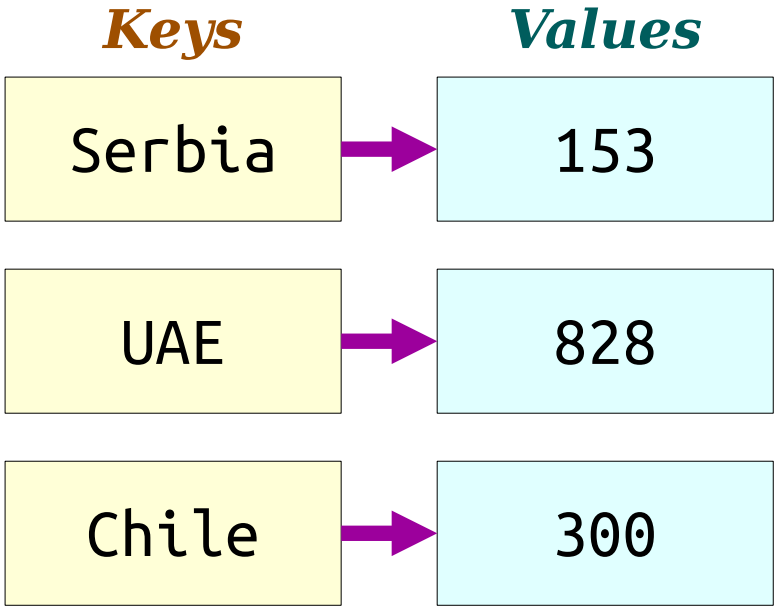
- We can loop over the keys in a map with a range-based for loop.



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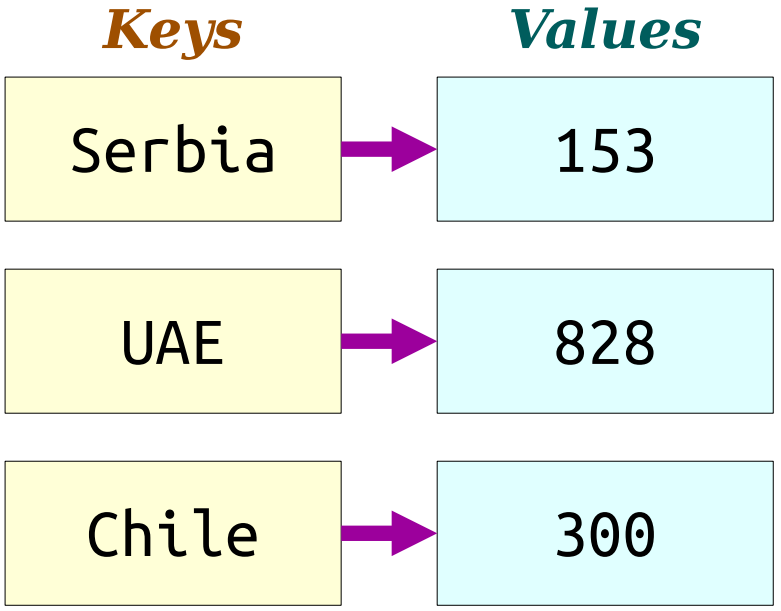


```
for (string key: heights) {
    cout << heights[key] << endl;
}
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Map

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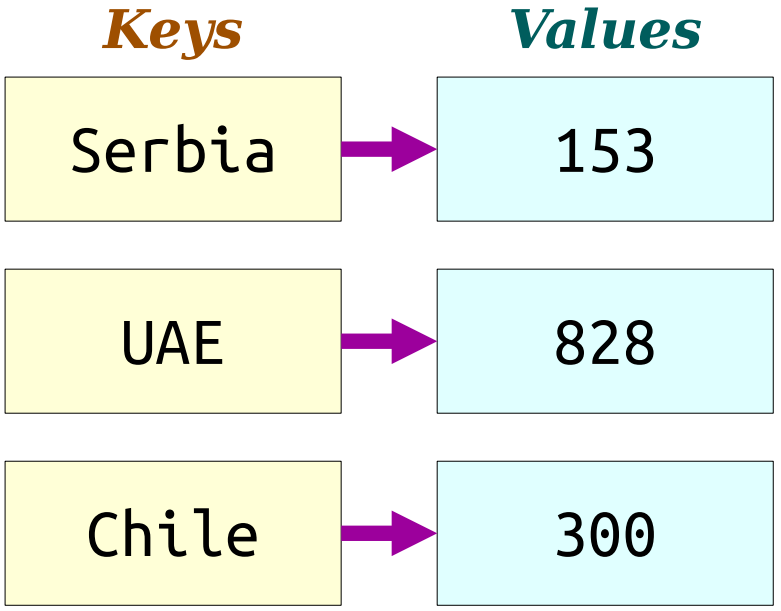
- We can check whether a key is present in the map.

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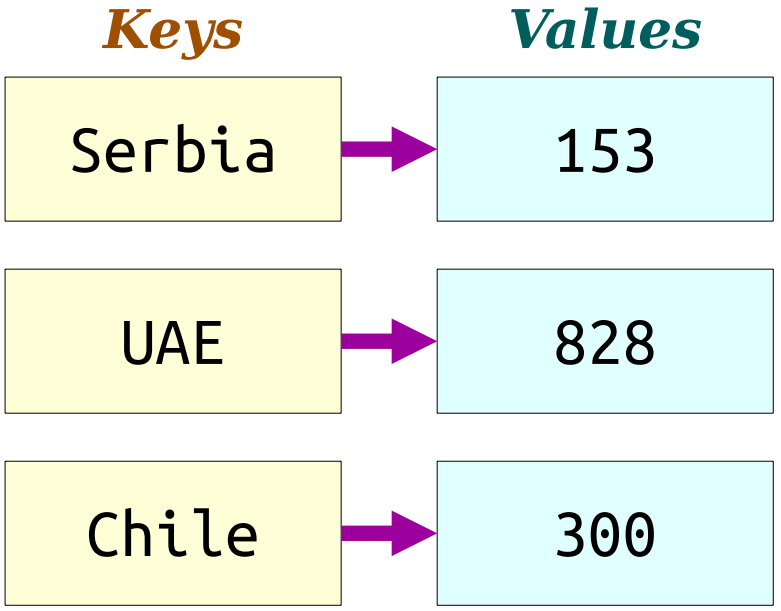


```
for (string key: heights) {
    cout << heights[key] << endl;
}

if (heights.containsKey("Mali") {
    cout << "BCEAO" << endl;
}
```

What’d I Say?

What’d I Say?

- Our program will prompt the user to repeatedly type in text.
- Each time, we’ll report how many previous times the user has typed in that text.
- We’ll use a `Map` to track frequencies!

`Map` Autoinsertion

Map Autoinsertion

```
Map<string, int> freqMap;
while (true) {
    string text = getLine("Enter some text: ");
    cout << "Times seen: " << freqMap[text] << endl;
    freqMap[text]++;
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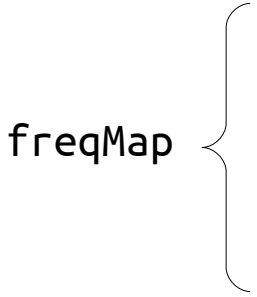

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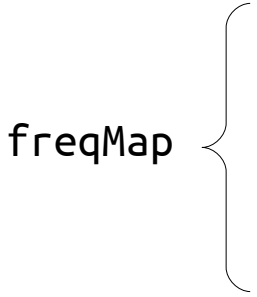

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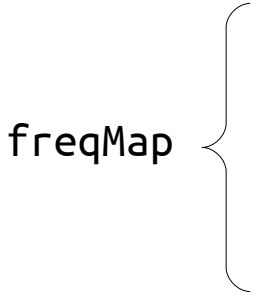

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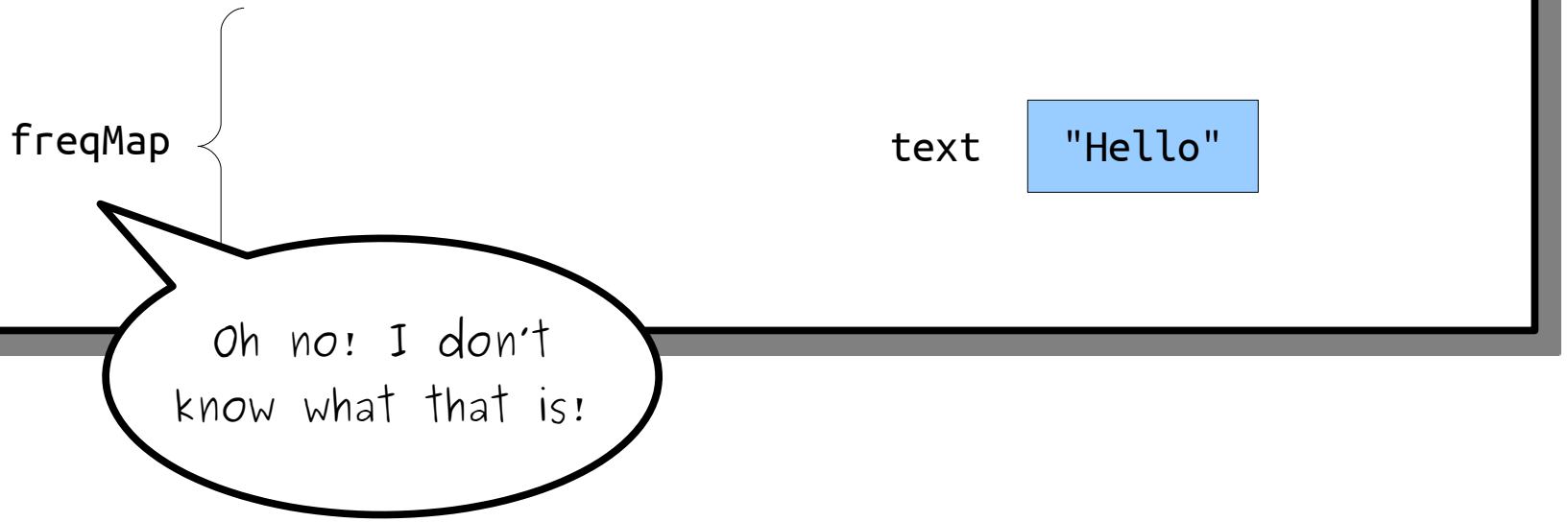

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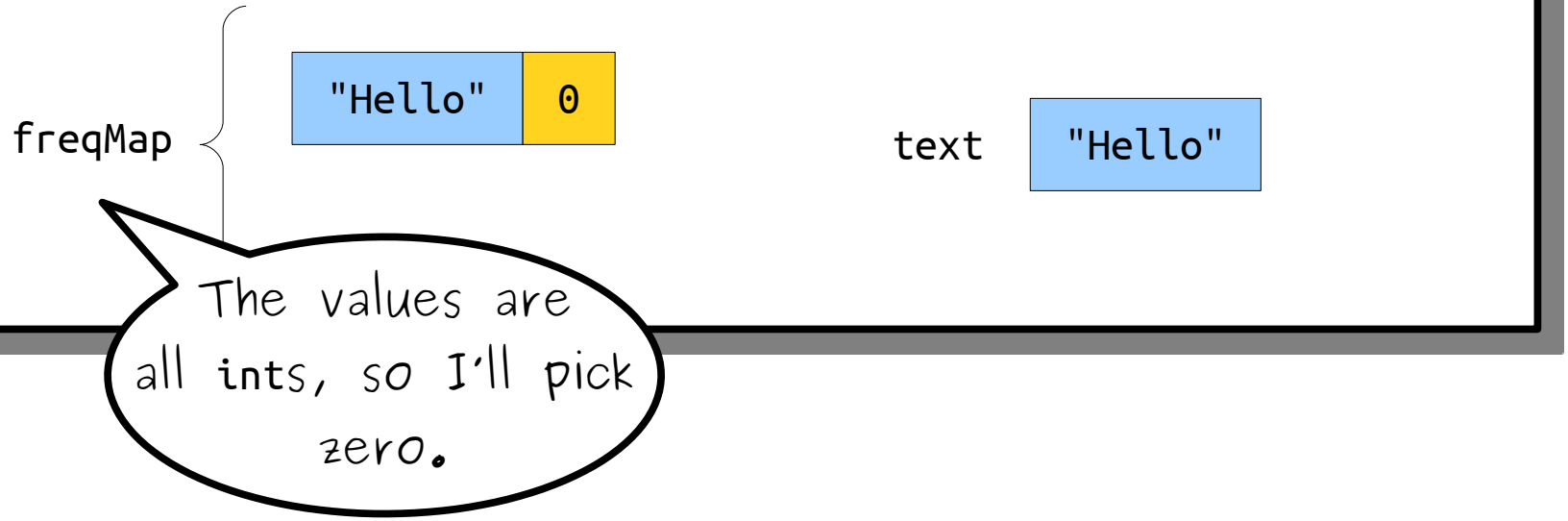

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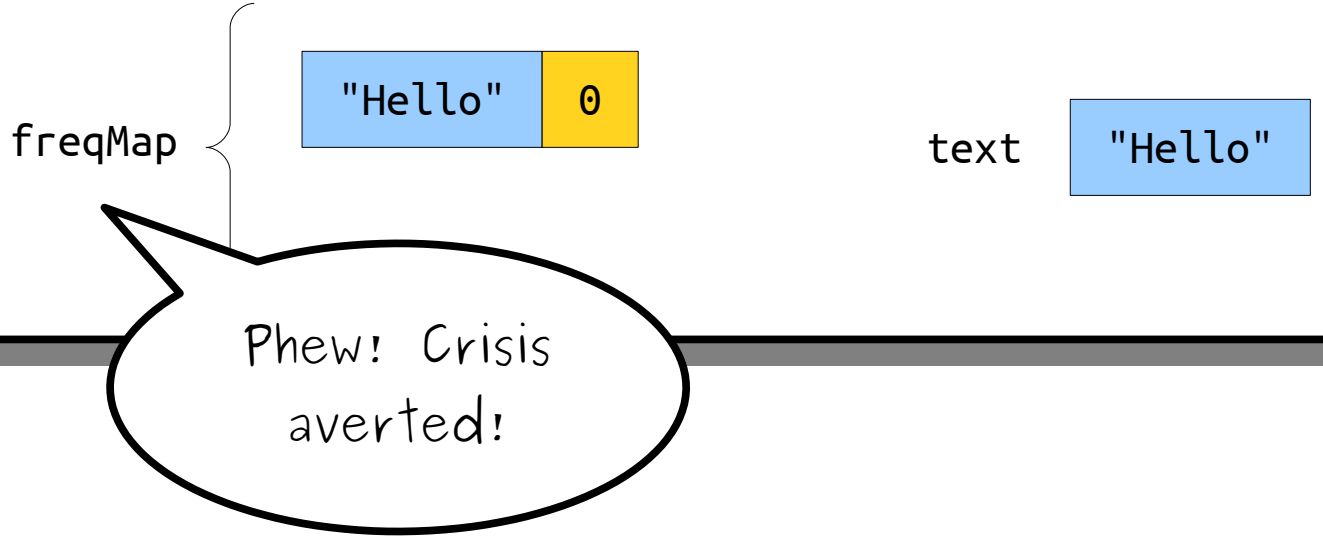

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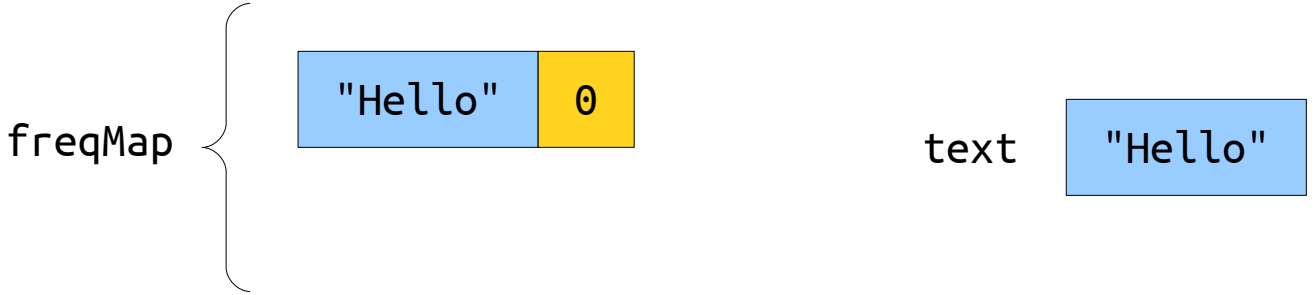

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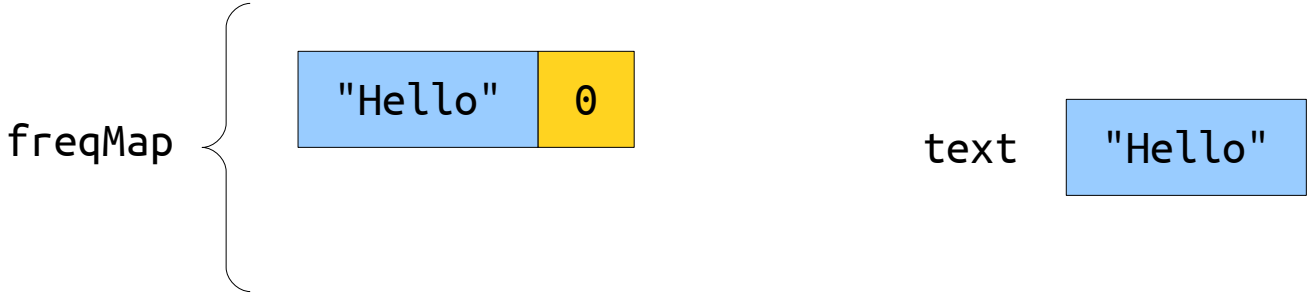

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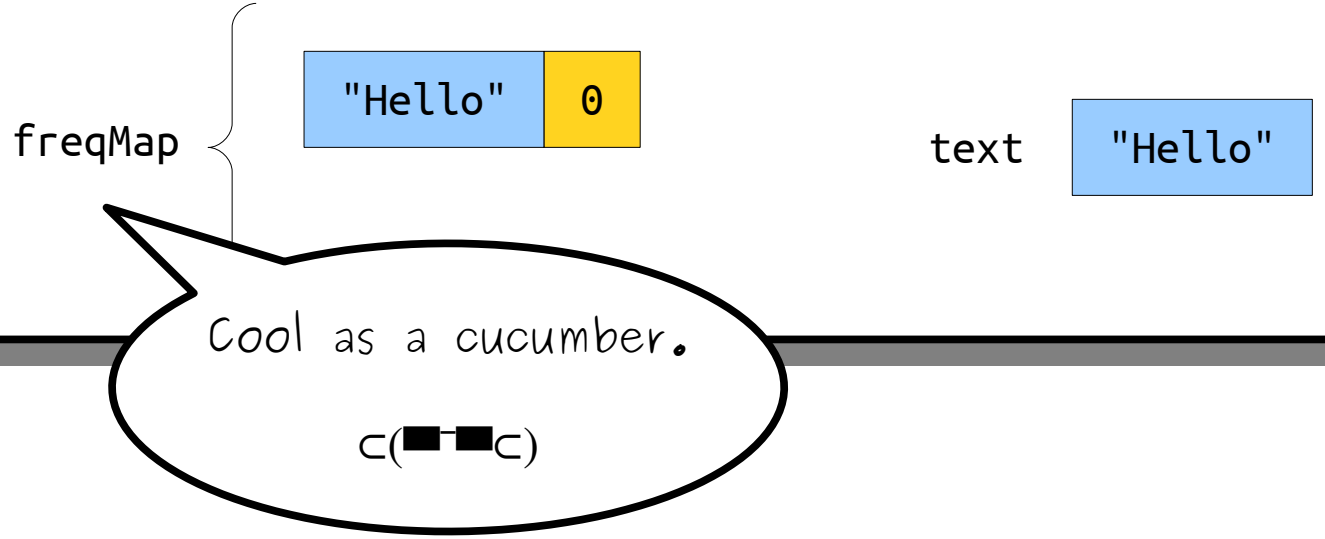

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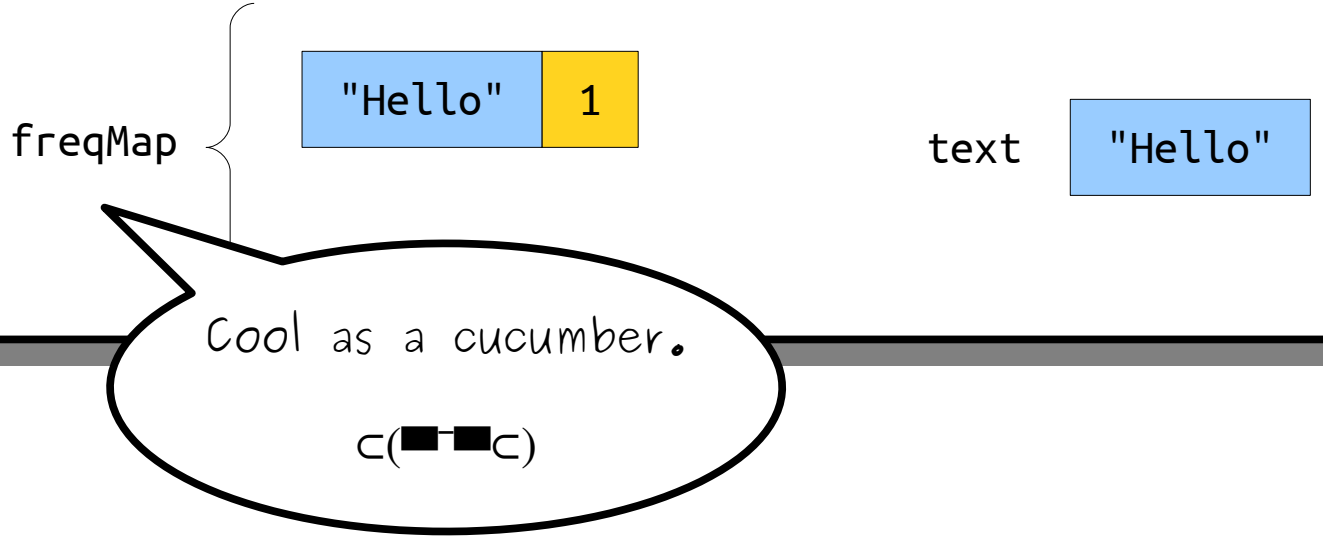

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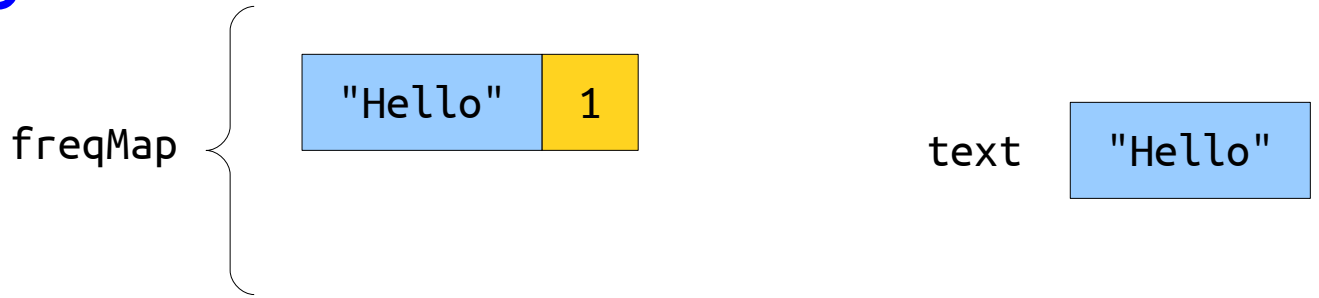

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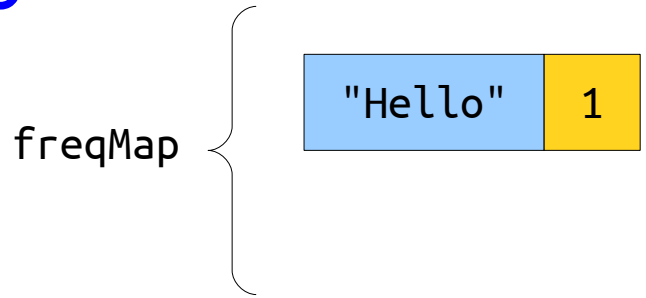

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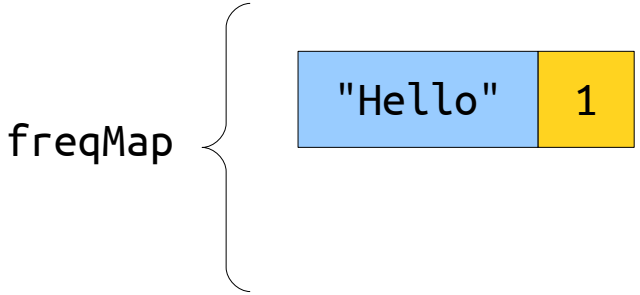

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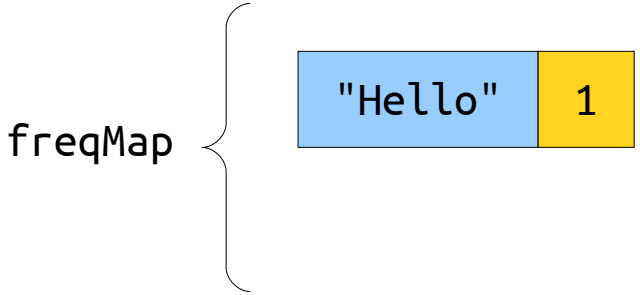

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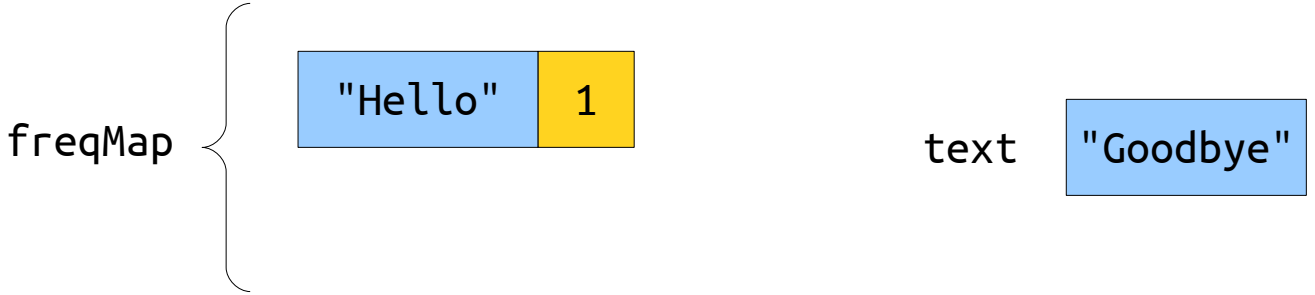

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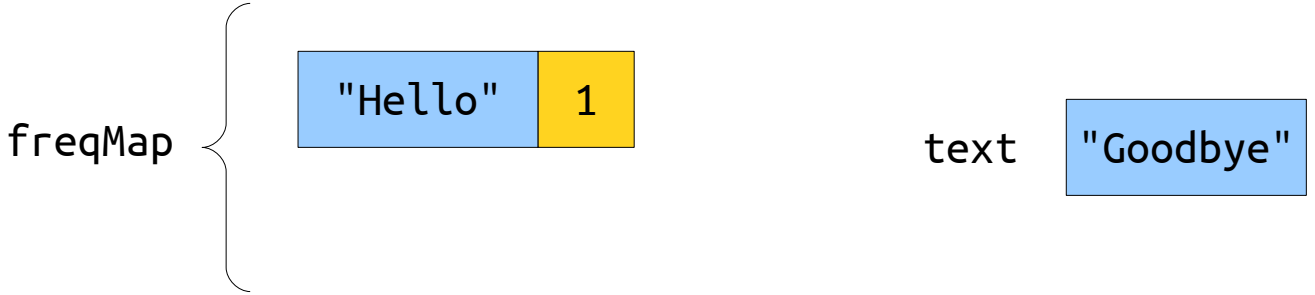

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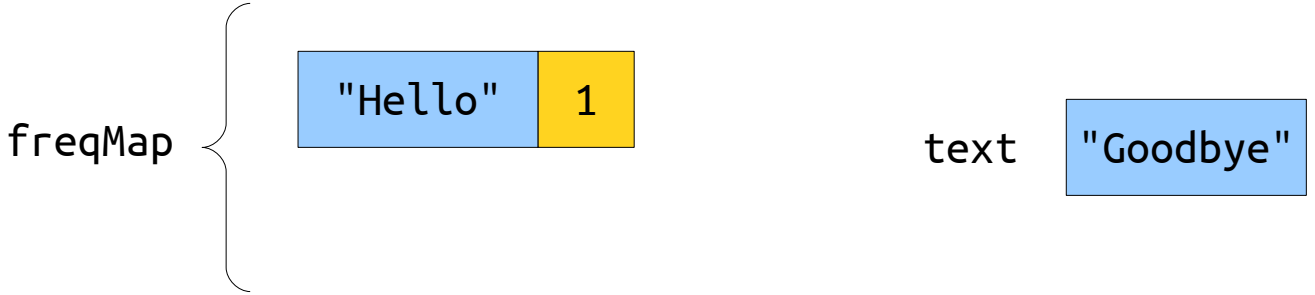

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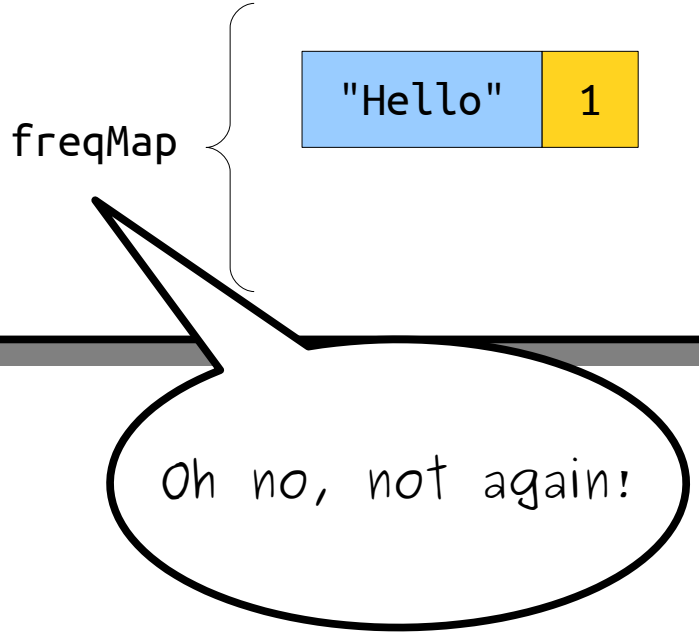

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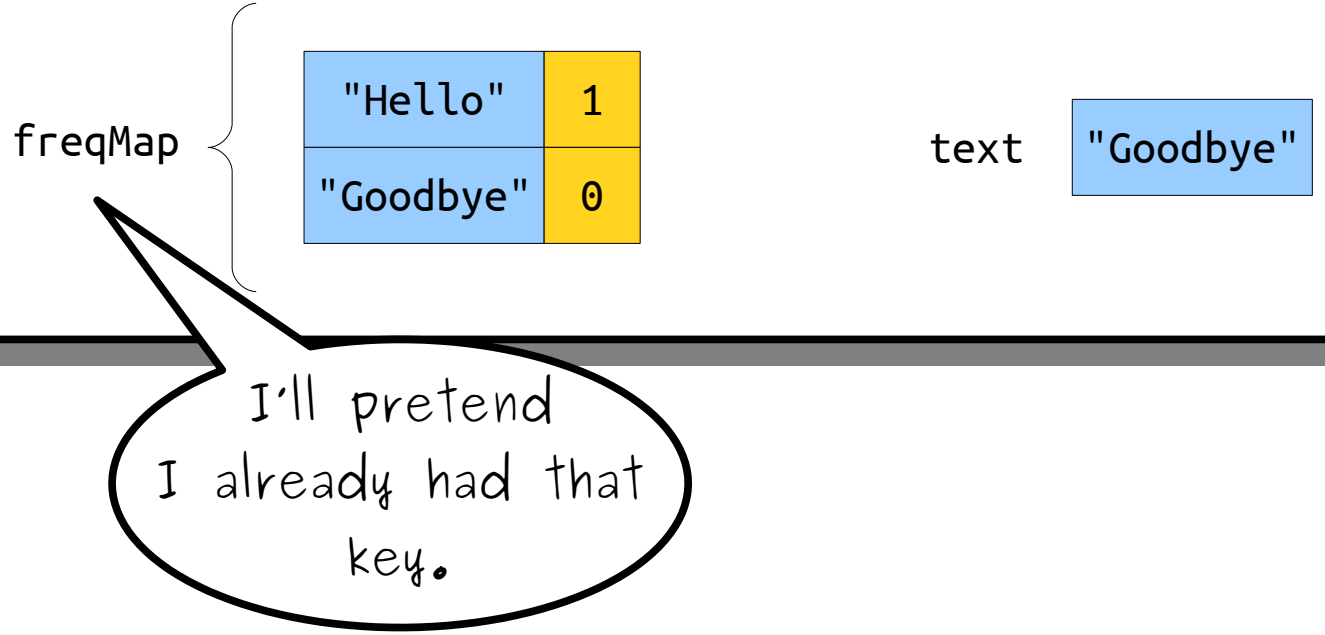

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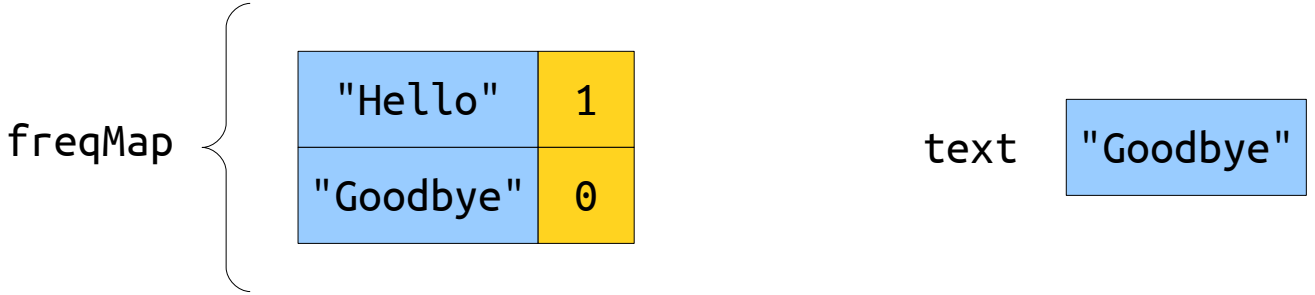

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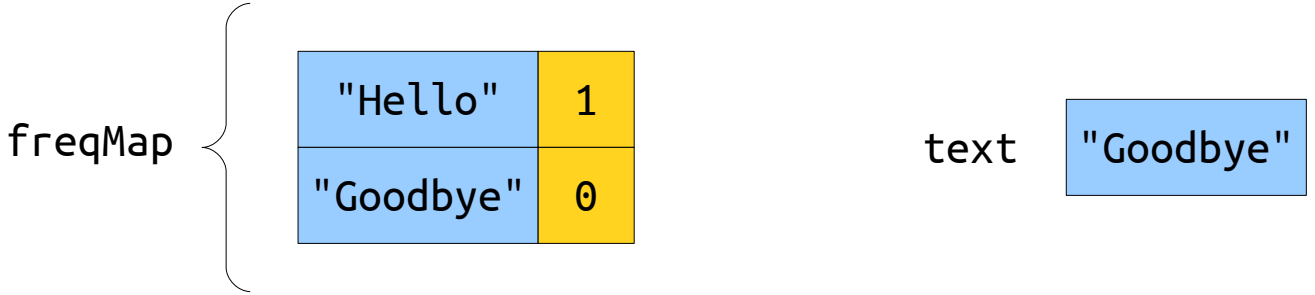

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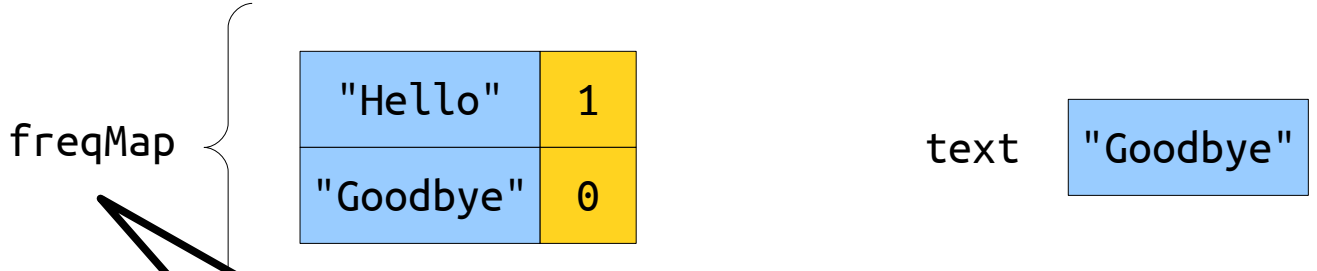

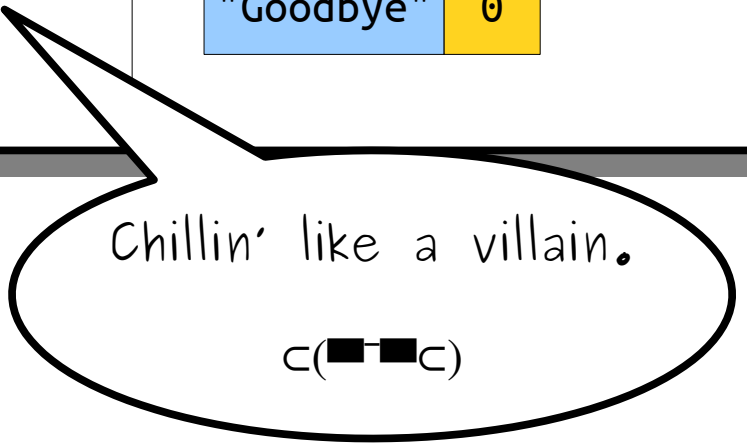

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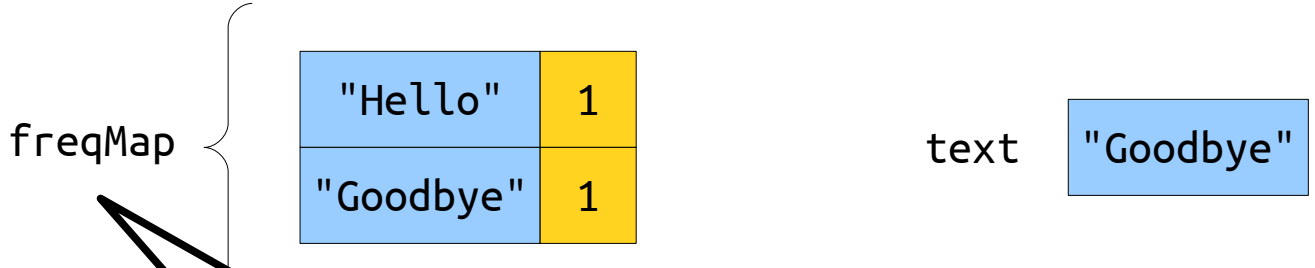

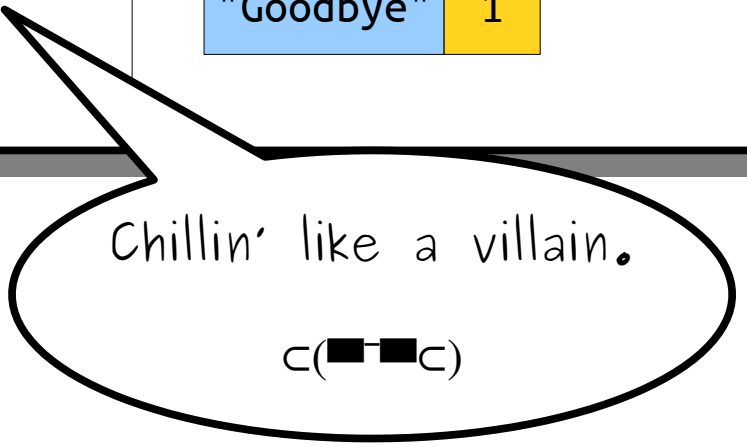

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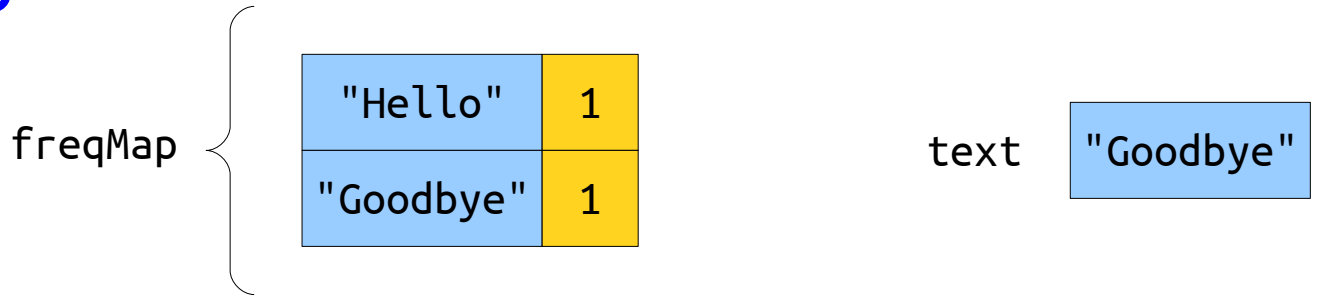

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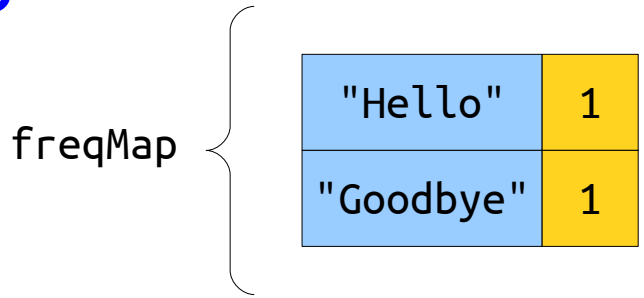


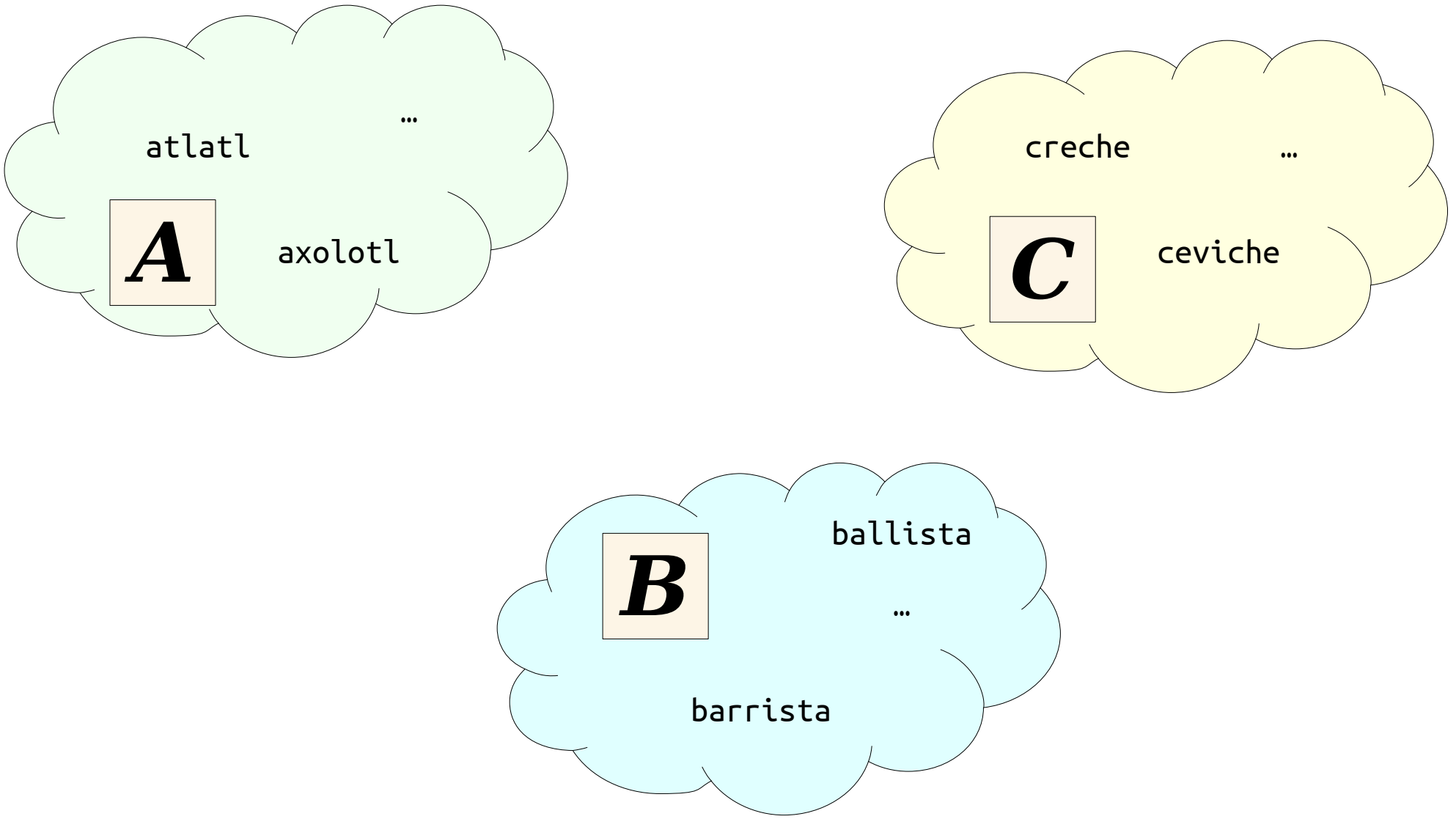
Map Autoinsertion

- If you look up something in a `Map` using square brackets,
  - if the key already exists, its associated value is returned; and
  - if the key doesn't exist, it's added in with a "sensible default" value, and that value is then returned.
- This can take some getting used to, but it's surprisingly convenient.

Type	***Default***
`int`	`0`
`double`	`0.0`
`bool`	`false`
`string`	`""`
Any Container	Empty container of that type
`char`	*`(it's complicated)`*

Grouping by First Letters

Grouping by First Letters



Grouping by First Letters

- We'll partition all English words into groups based on their first letter.
- To do so, we'll create a `Map` that associates each letter with words starting with that letter.
- What specific type of `Map` should it be (e.g. `Map<int, double>`, `Map<string, string>`, etc.)?

Answer online at
https://cs106b.stanford.edu/pollev

Map Autoinsertion

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Lexicon english("EnglishWords.txt");

Map<char, Lexicon> wordsByFirstLetter;
for (string word: english) {
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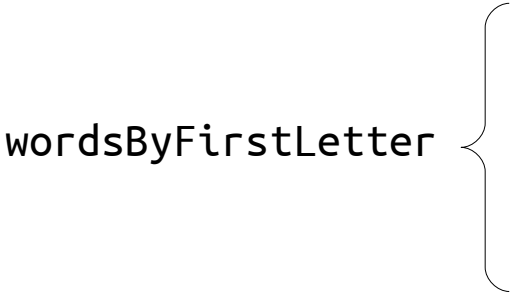

word "first"

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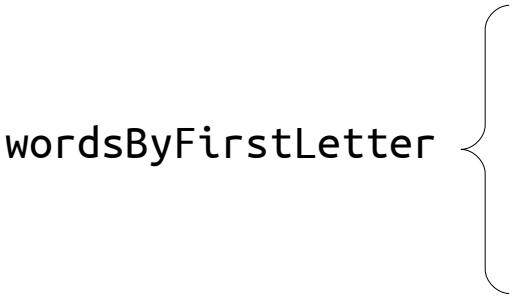

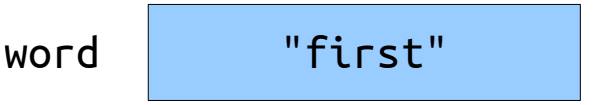

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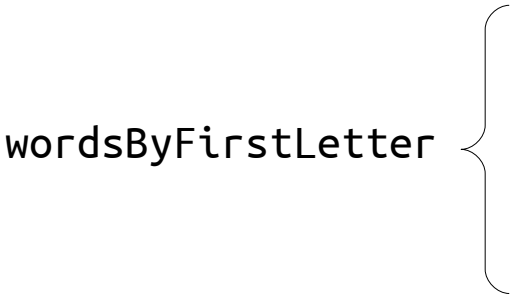

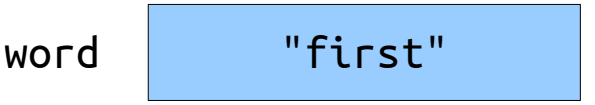

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wordsByFirstLetter

word "first"

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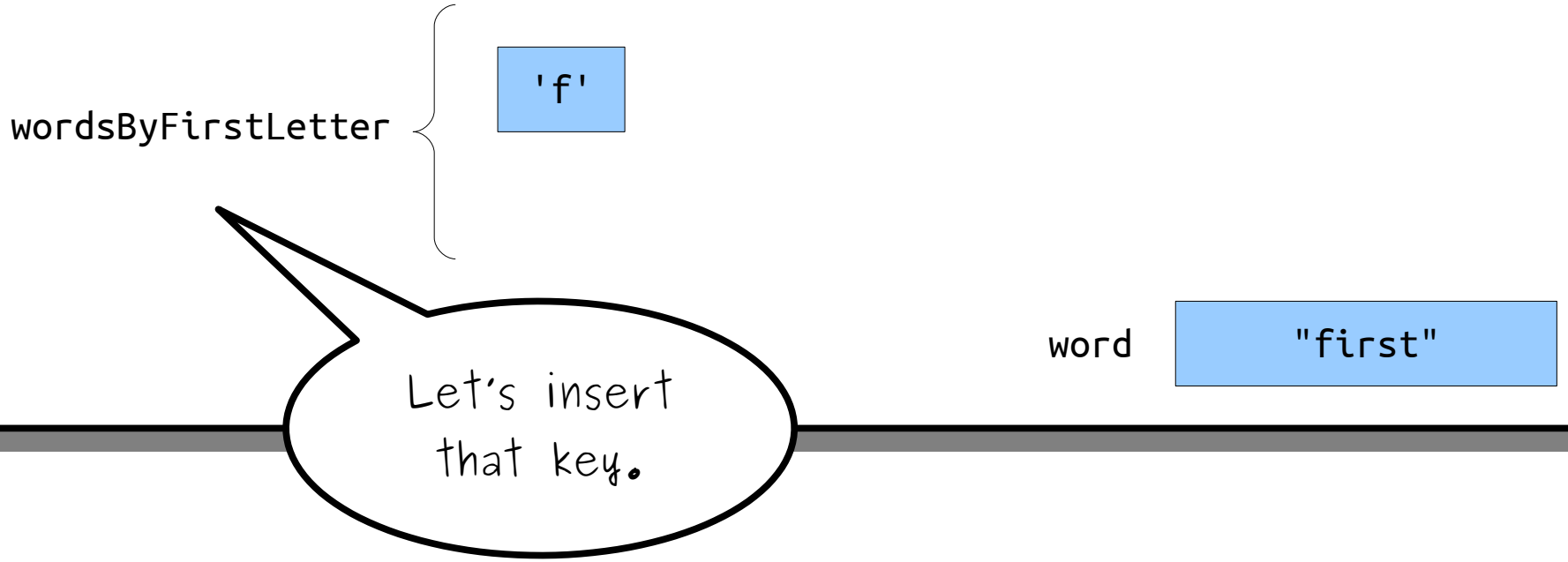

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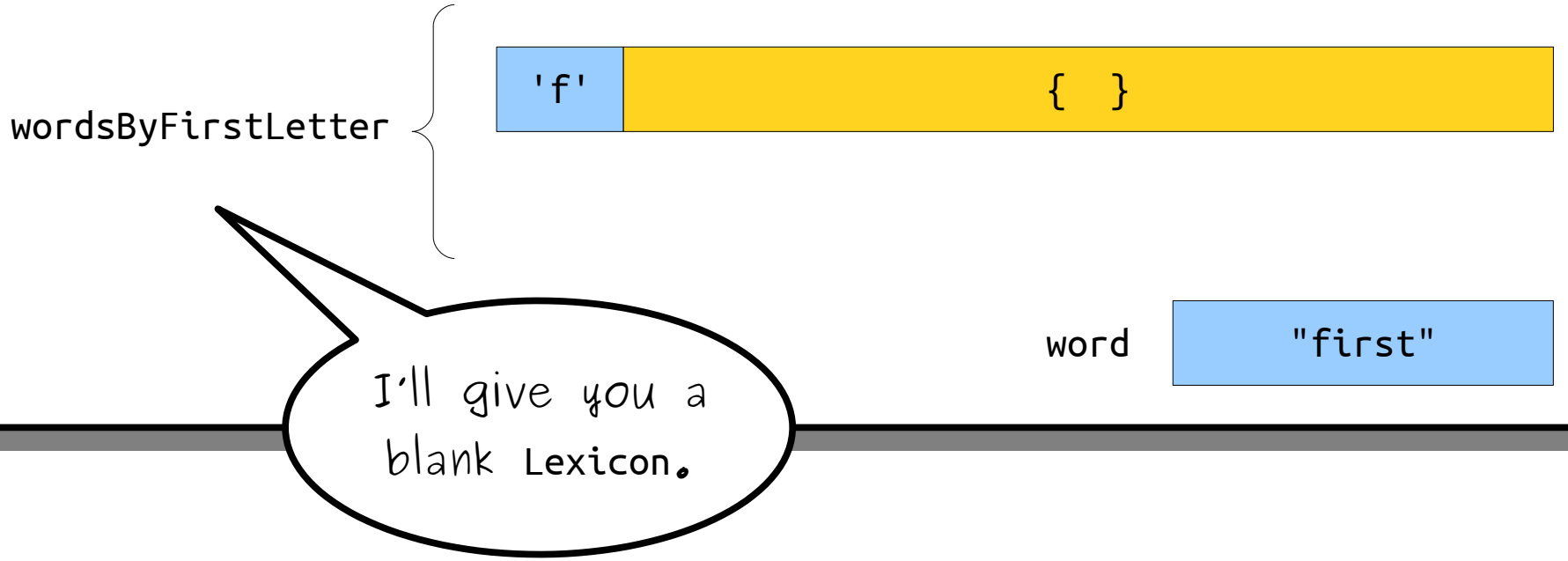

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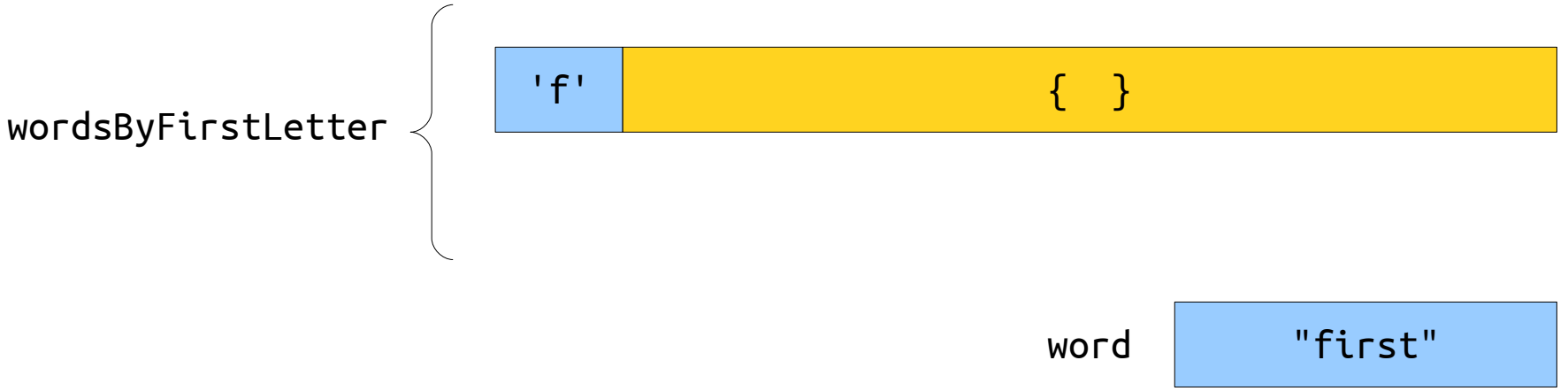

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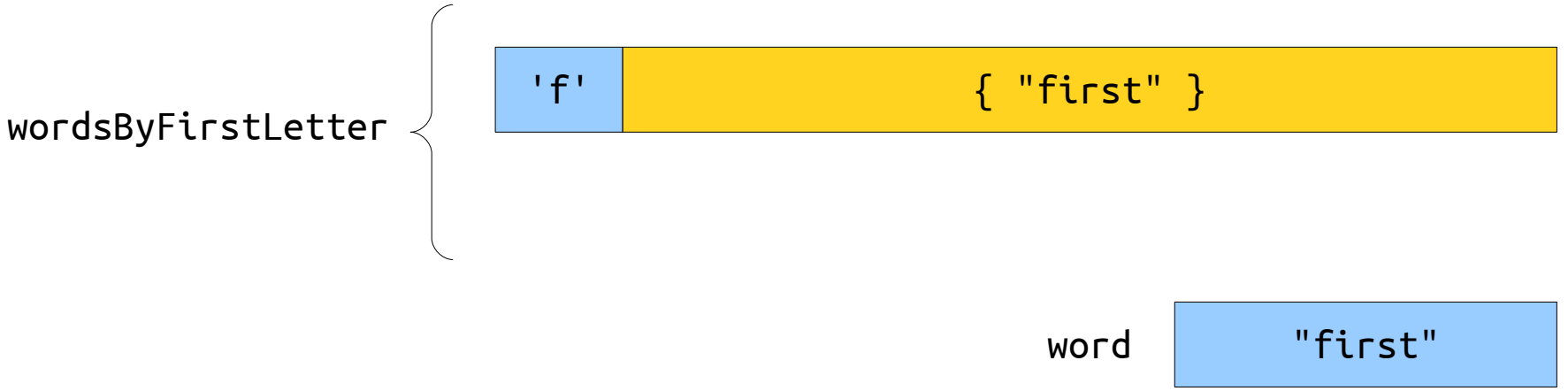

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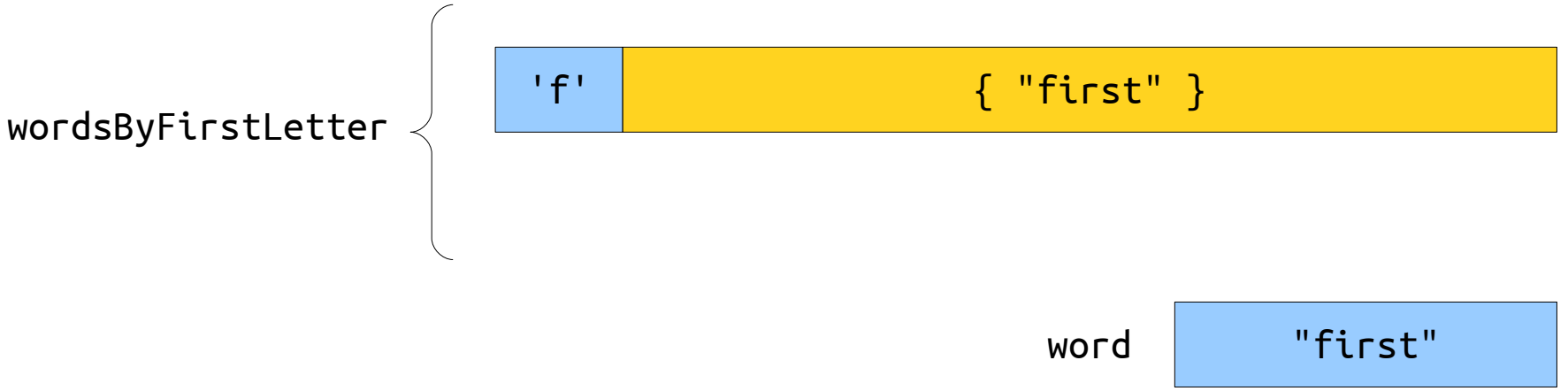

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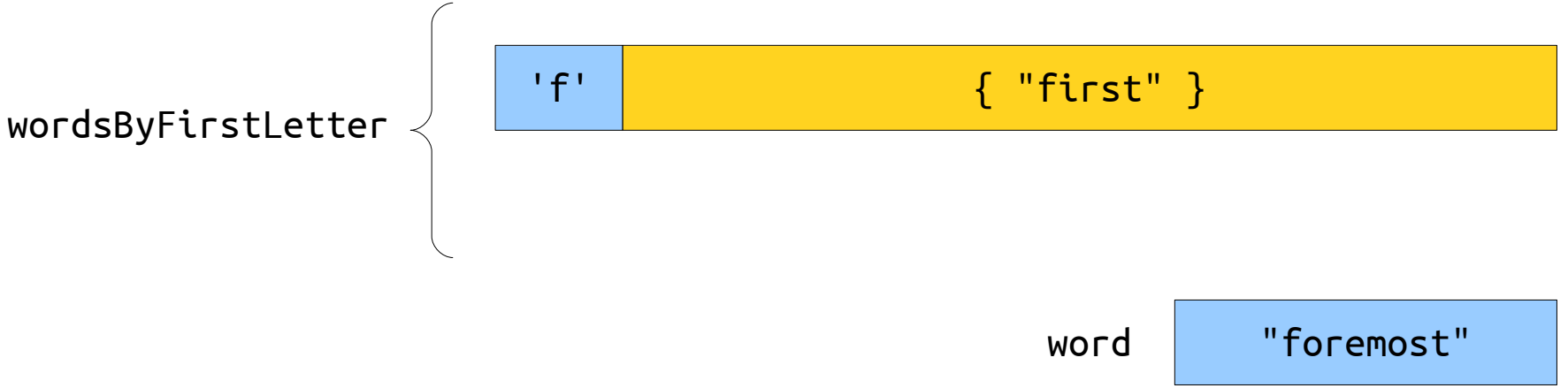

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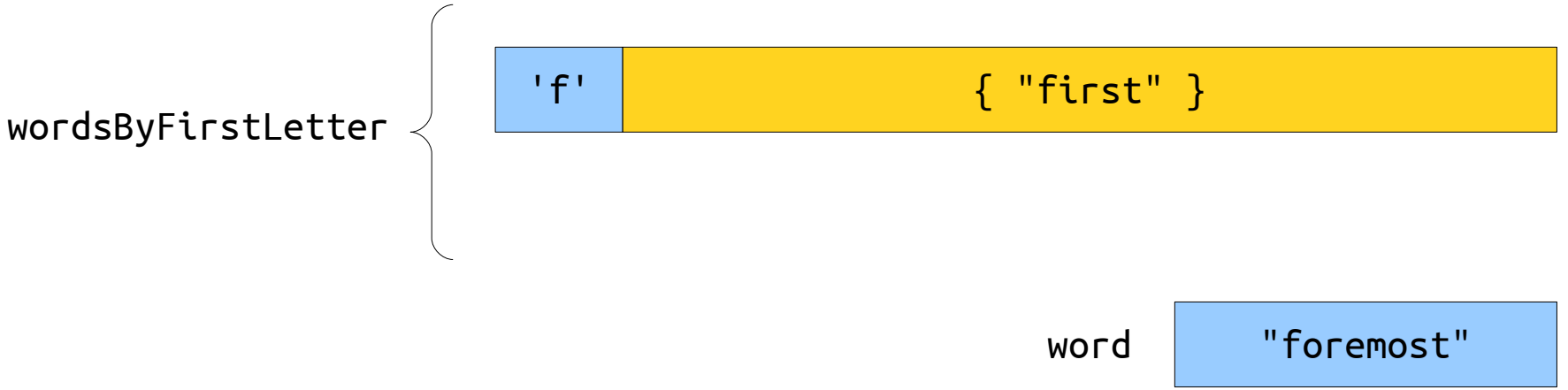

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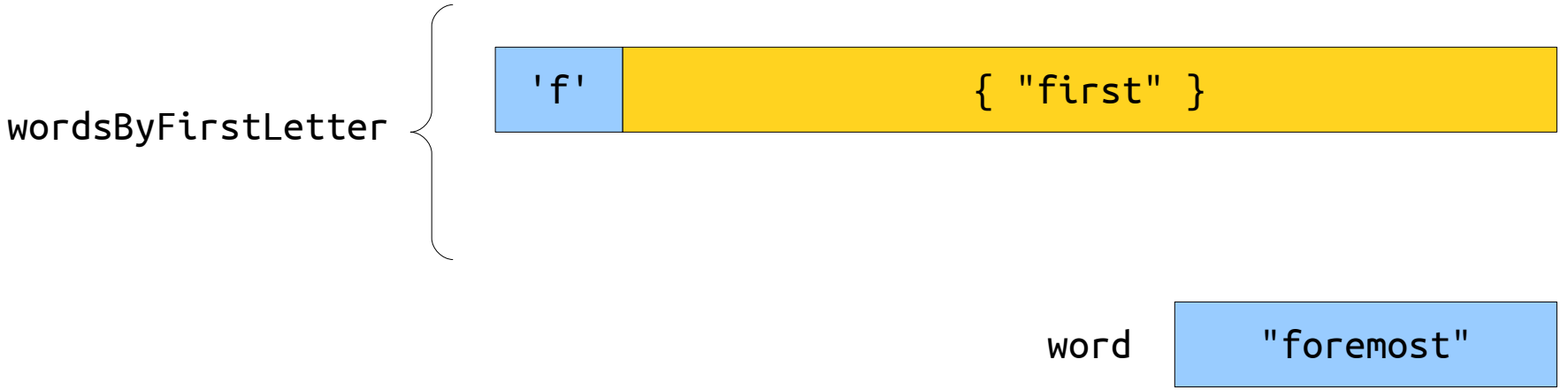

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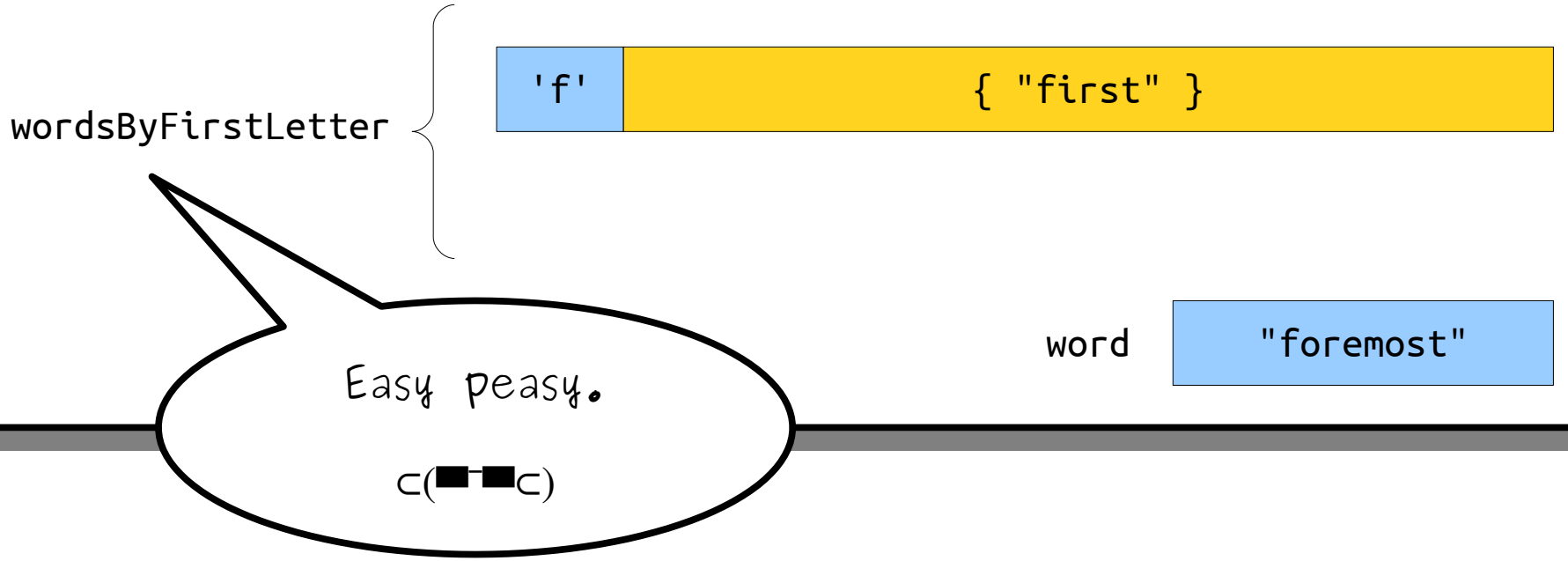

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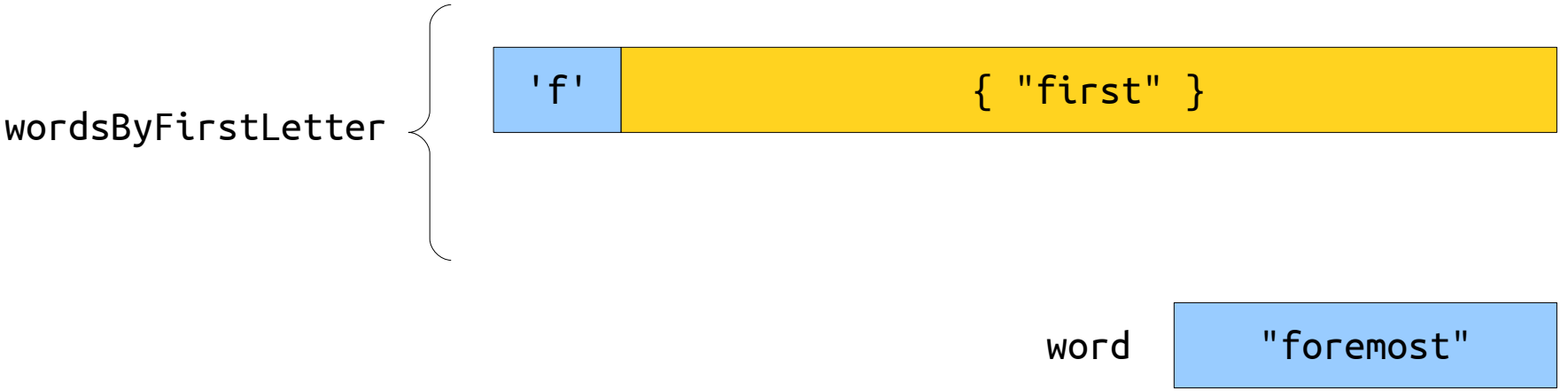

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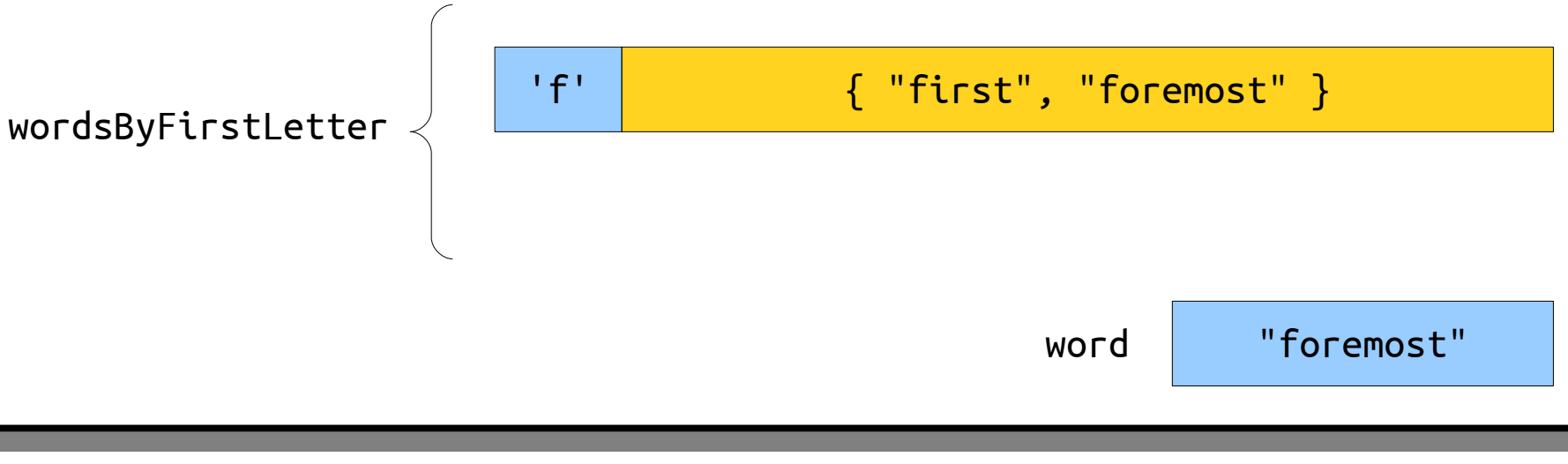

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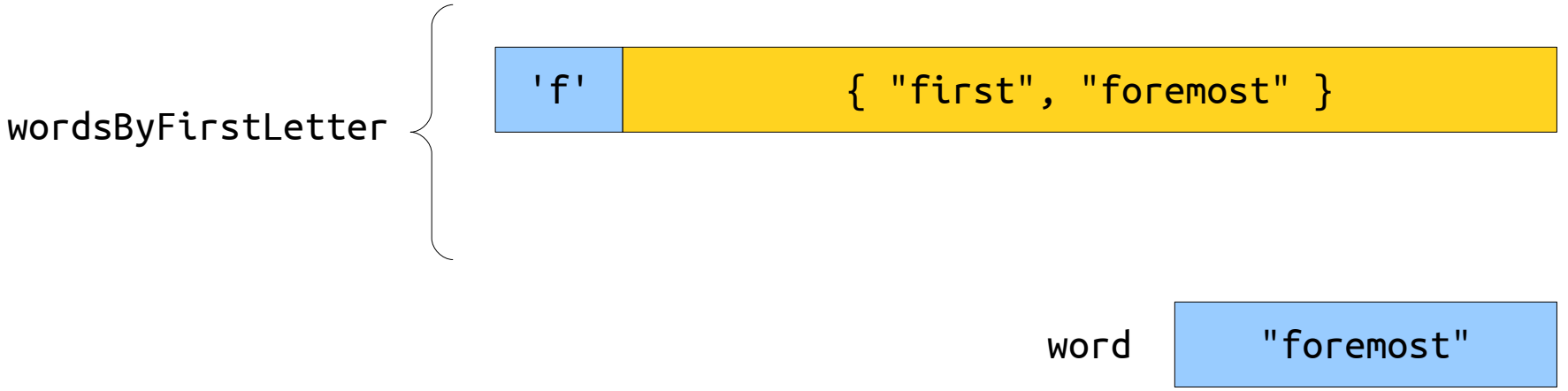

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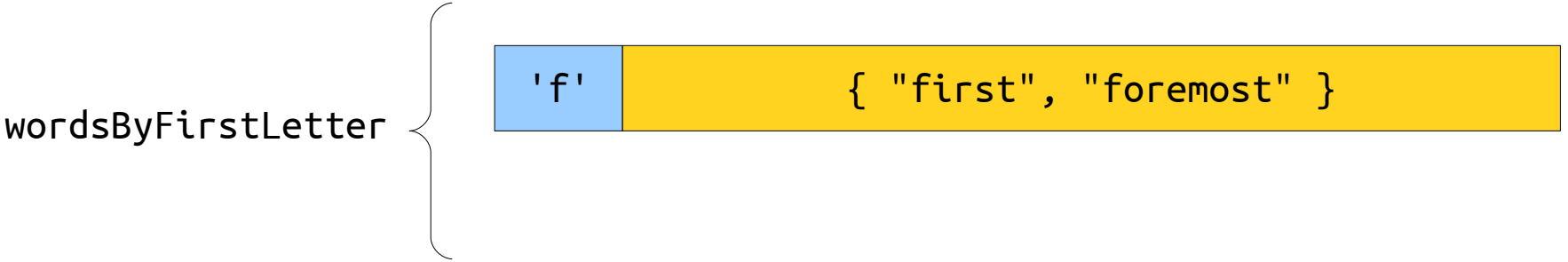

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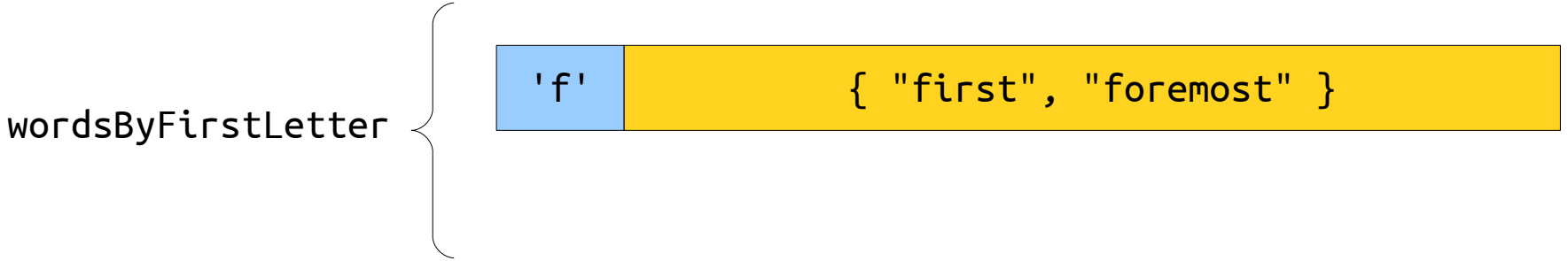

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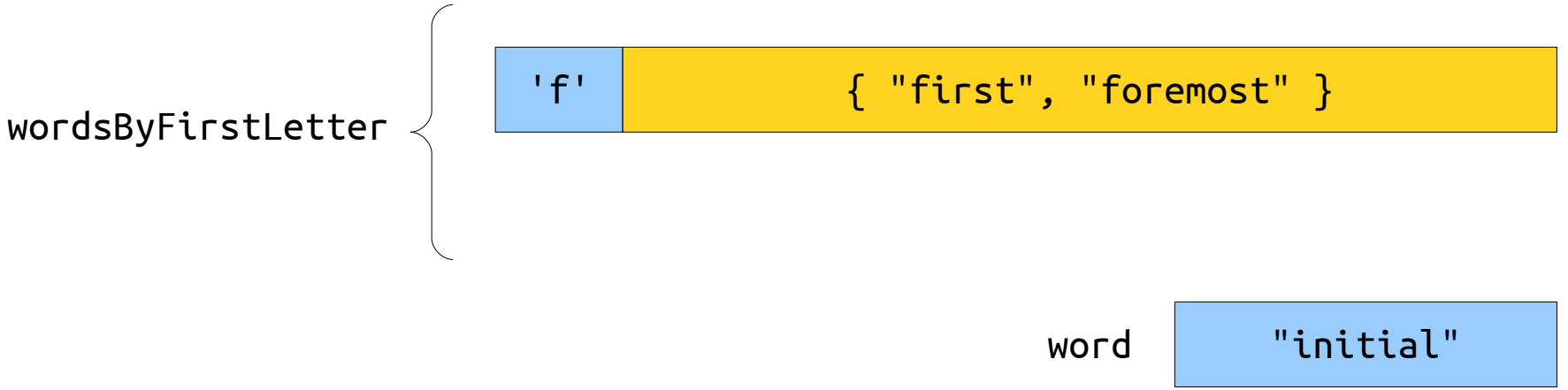

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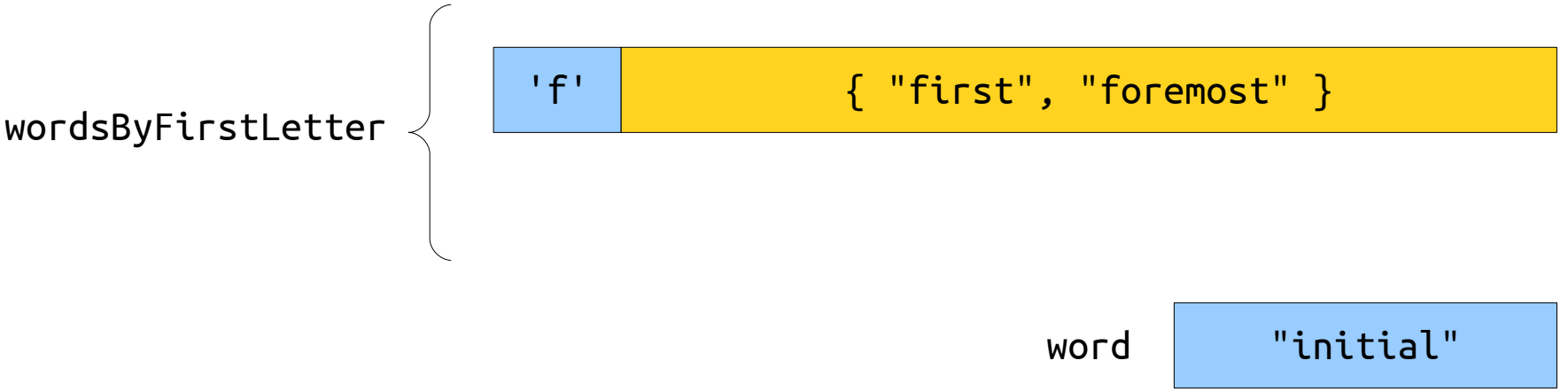

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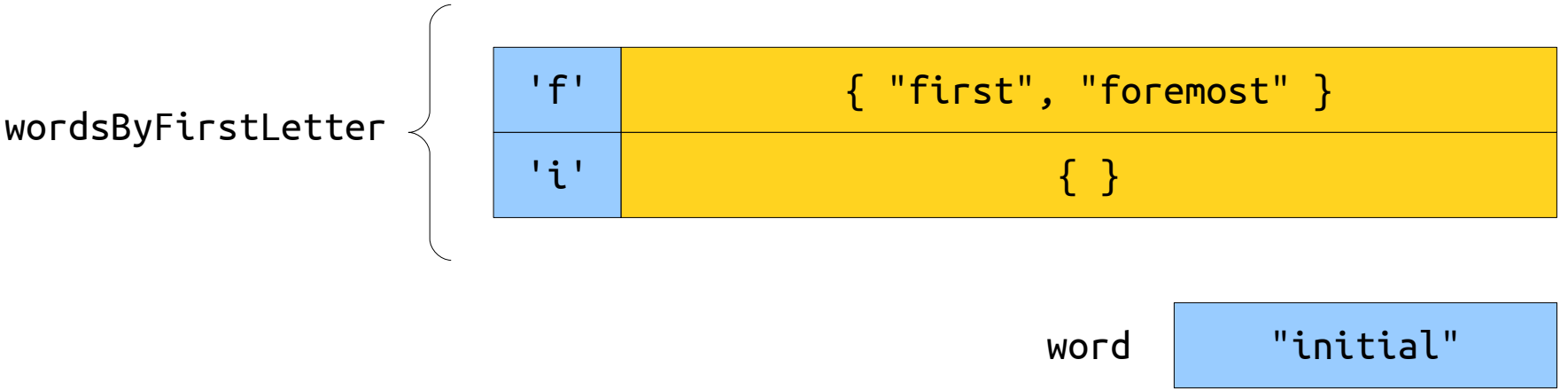

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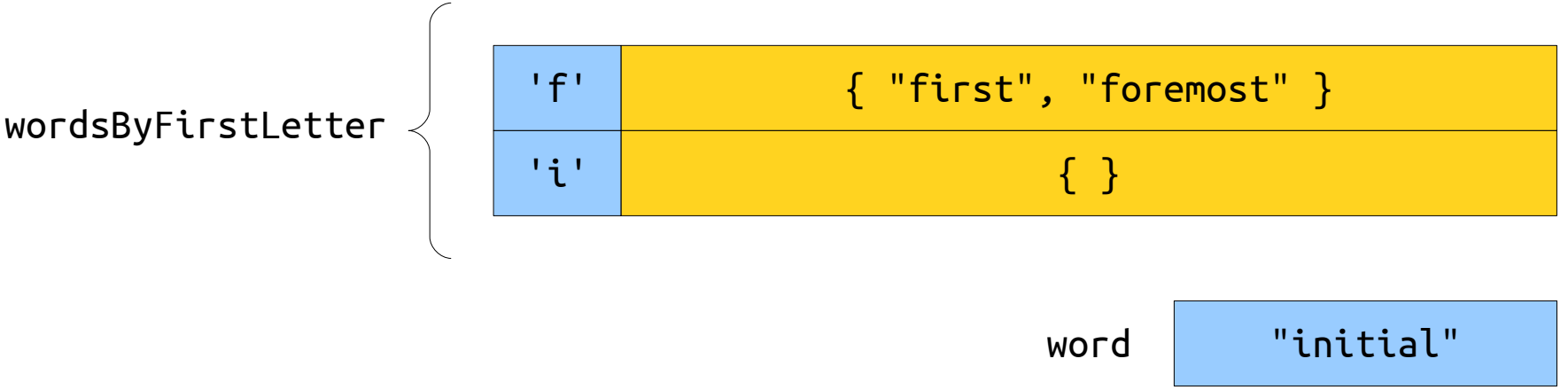

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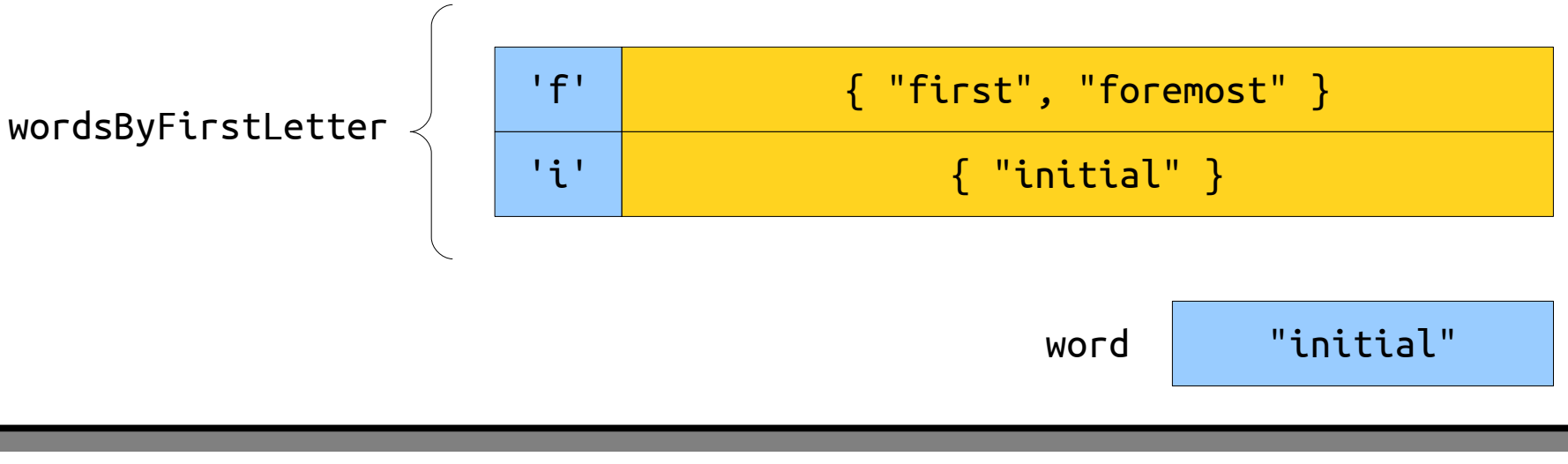
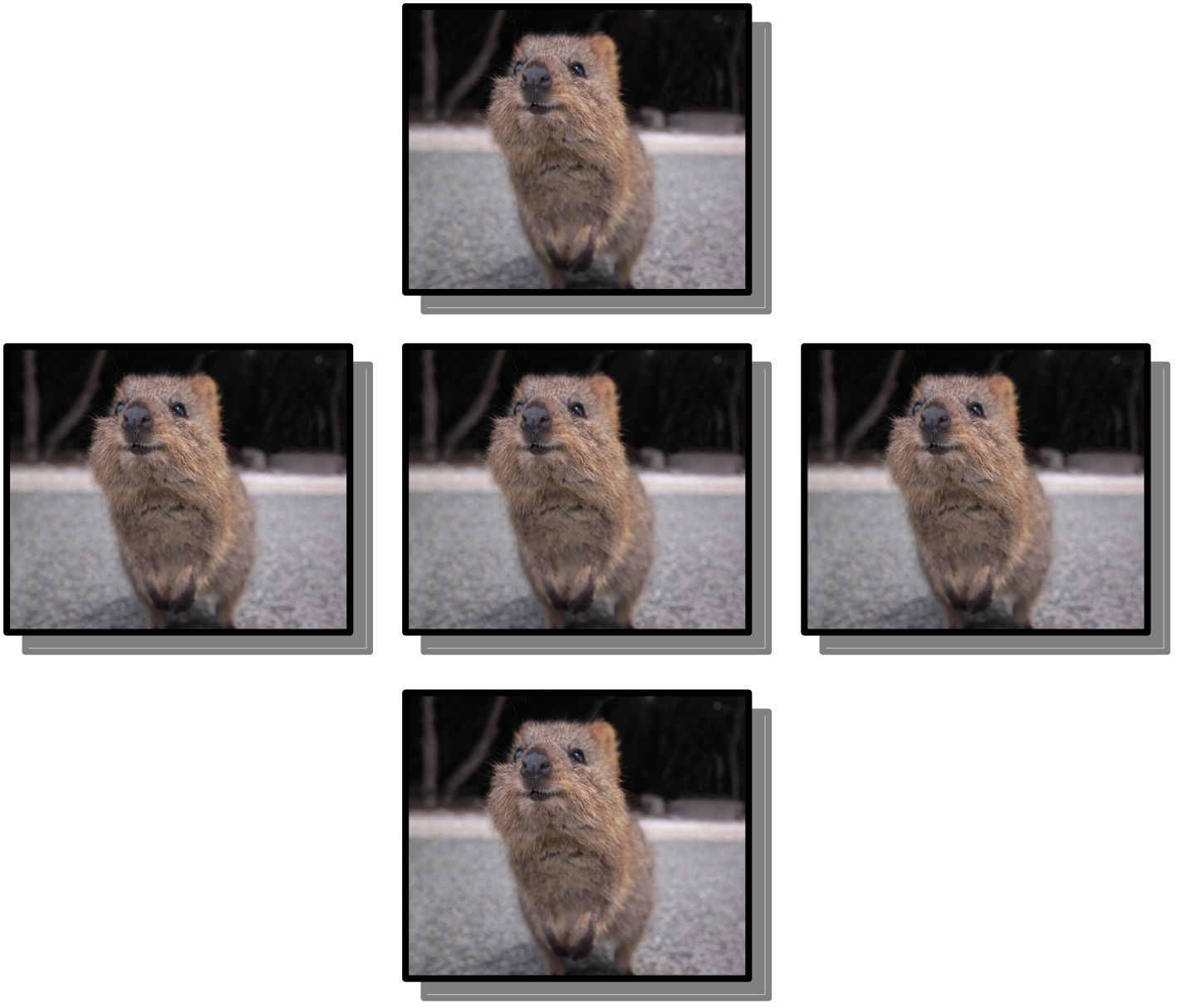
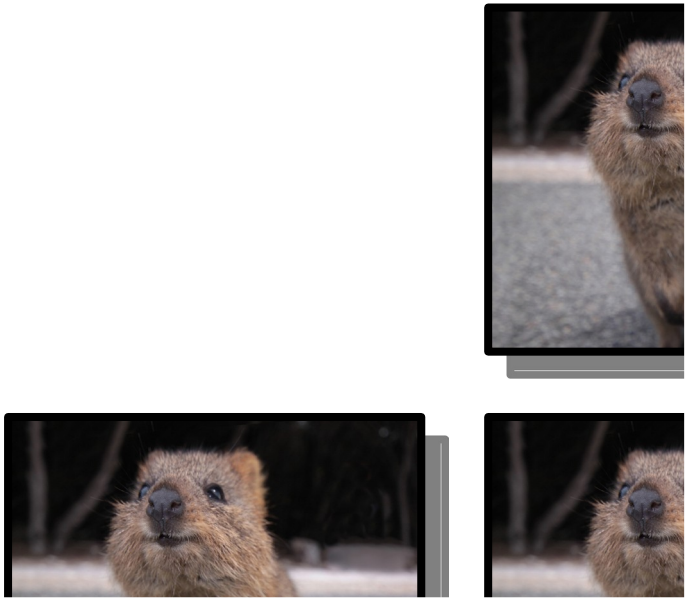


Quokka

Quokka Quincunx



Quarter Quokka Quincunx



Your Action Items

- ***Read Chapter 5.***
  - It's all about container types, and it'll fill in any remaining gaps from this week.
- ***Read the Style Guide***
  - Coding style is important! We want to be clear with our expectations.
- ***Keep Working on Assignment 1.***
  - If you're following our recommended timetable, you'll have finished Debugger Warmups and Fire at this point and will be working on Only Connect.

Next Time

- ***Stacks and Queues***
  - Specialized containers for specialized sequences.
  - Applications to text analysis and music.