Collections, Part Three

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

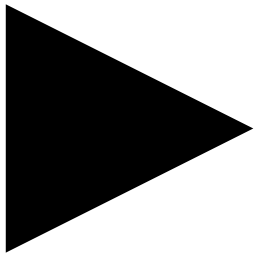
Introducing the Dikdik

And a Music Recommendation

Time-Out for Announcements!

Assignment 2

- Assignment 2 (Fun with Collections) goes out today. It's due next Friday.
  - Explore the impact of sea level rise.
  - Build a personality quiz!
- We've provided a suggested timetable for completing this assignment on the front page of the handout. Aim to stick to this timeline; you've got plenty of time to complete things if you start early.
- ***You must complete this assignment individually***. Working in pairs is not permitted on this assignment.



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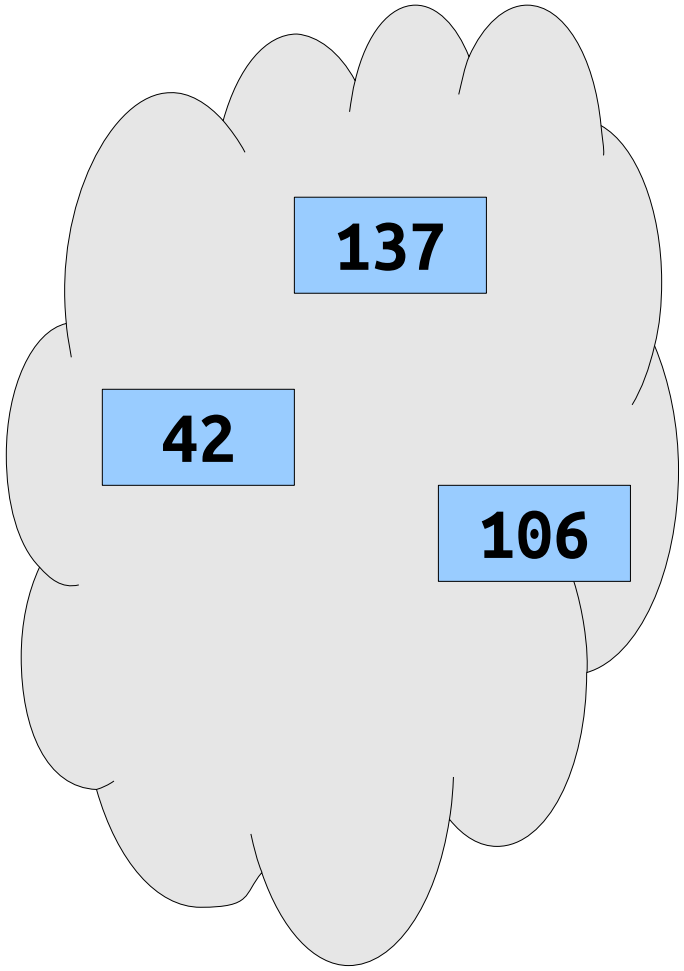

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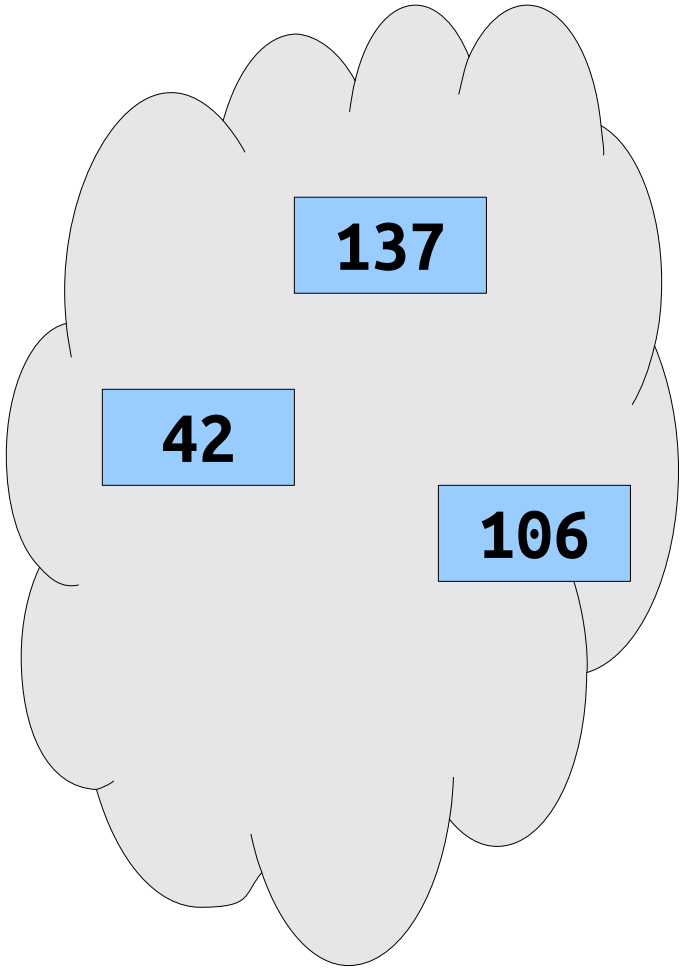

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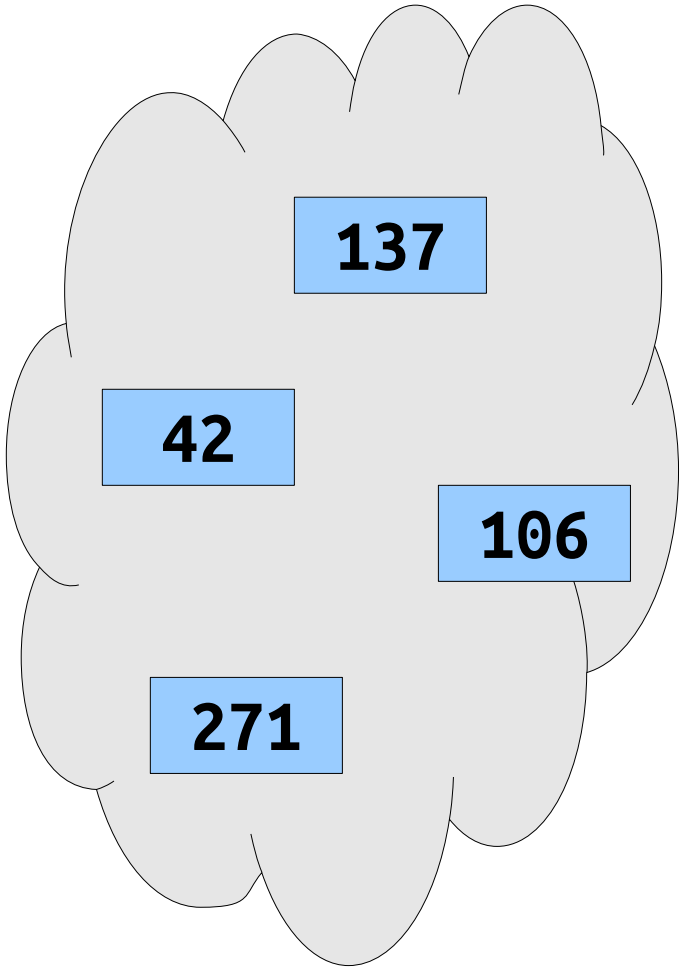

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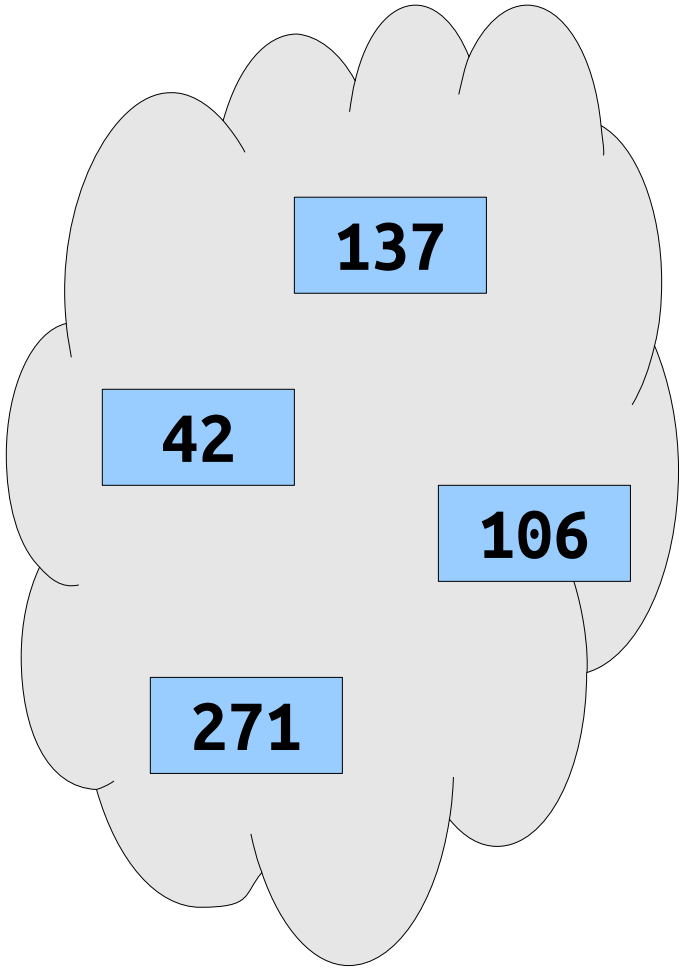

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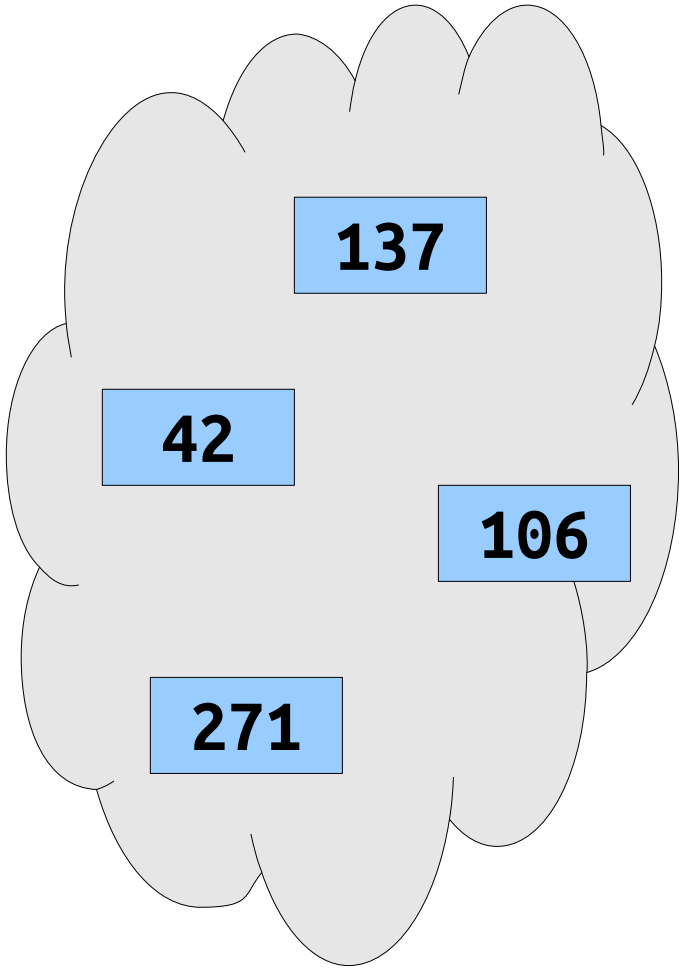

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values -= 106;
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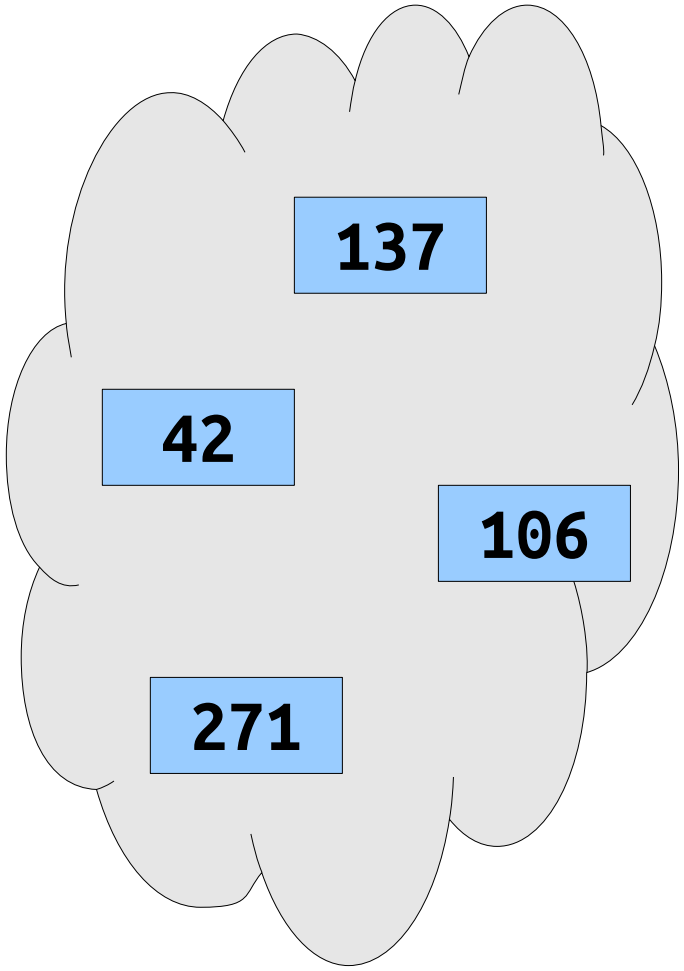

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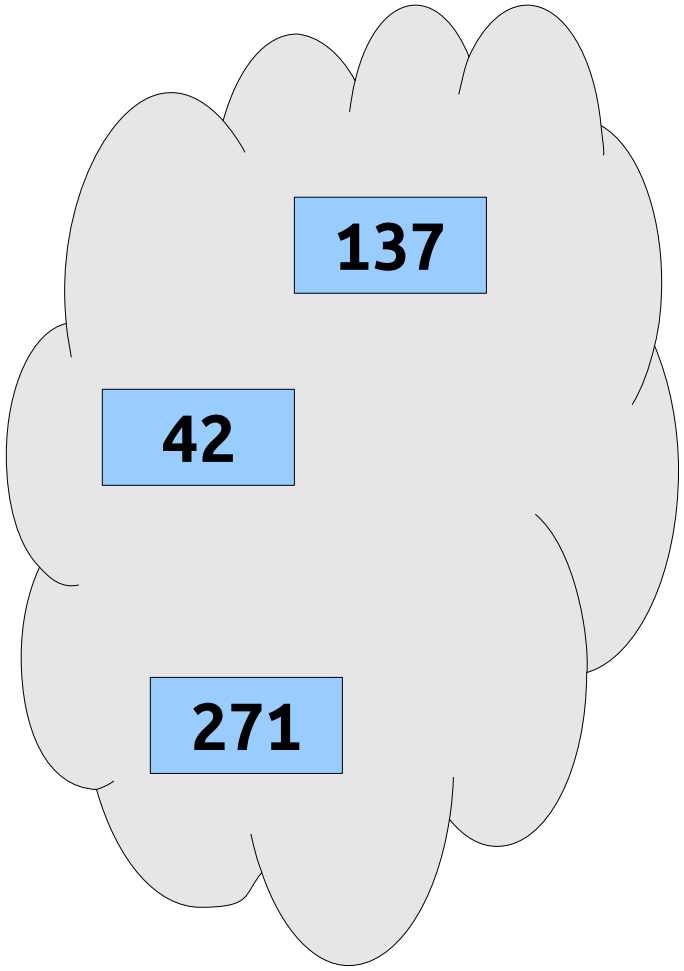

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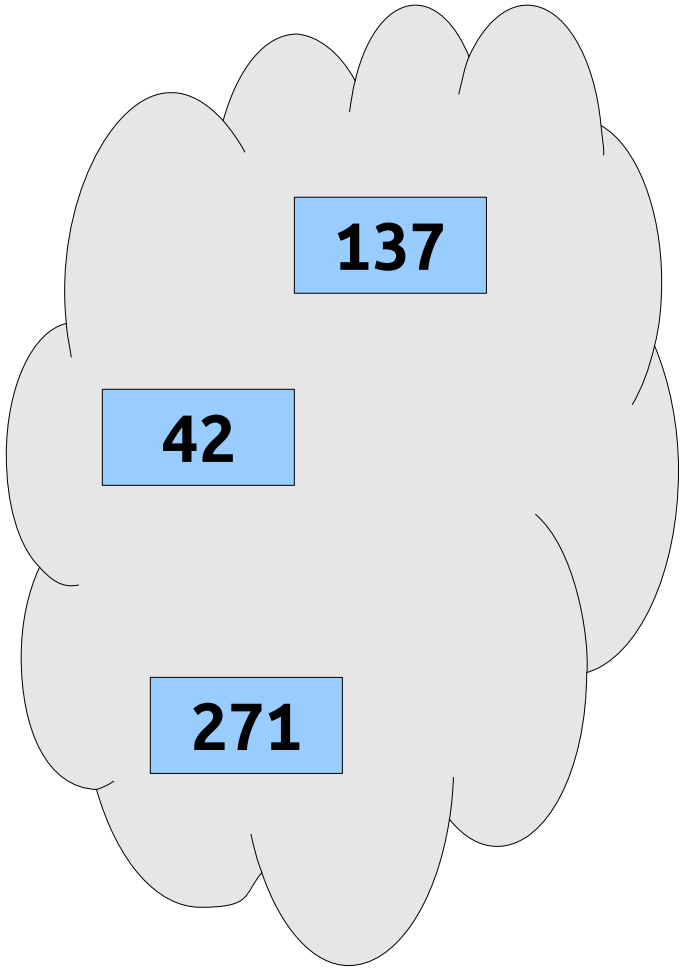

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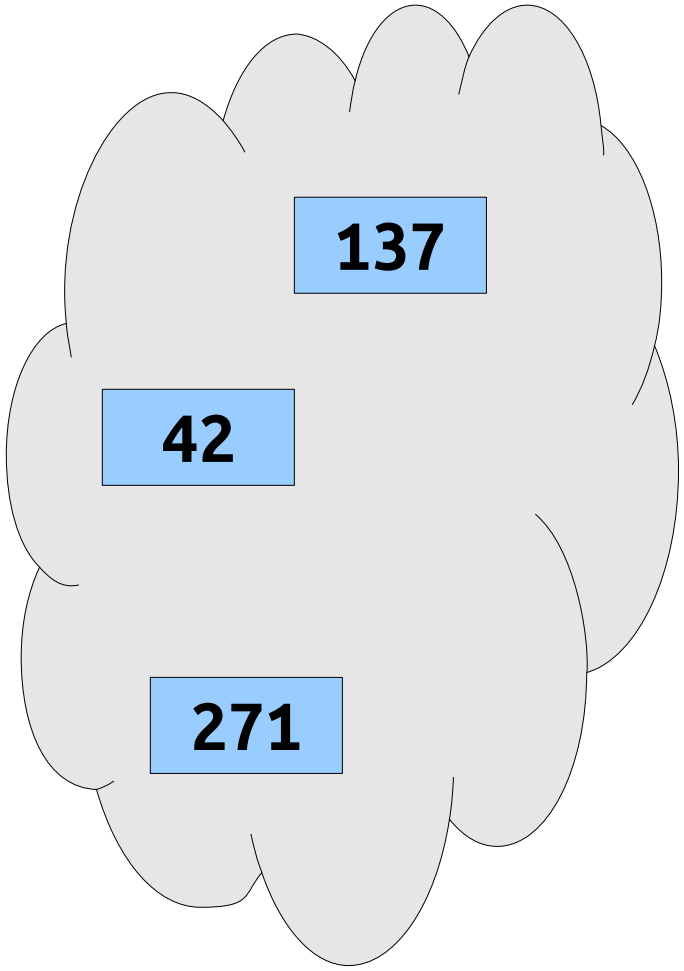

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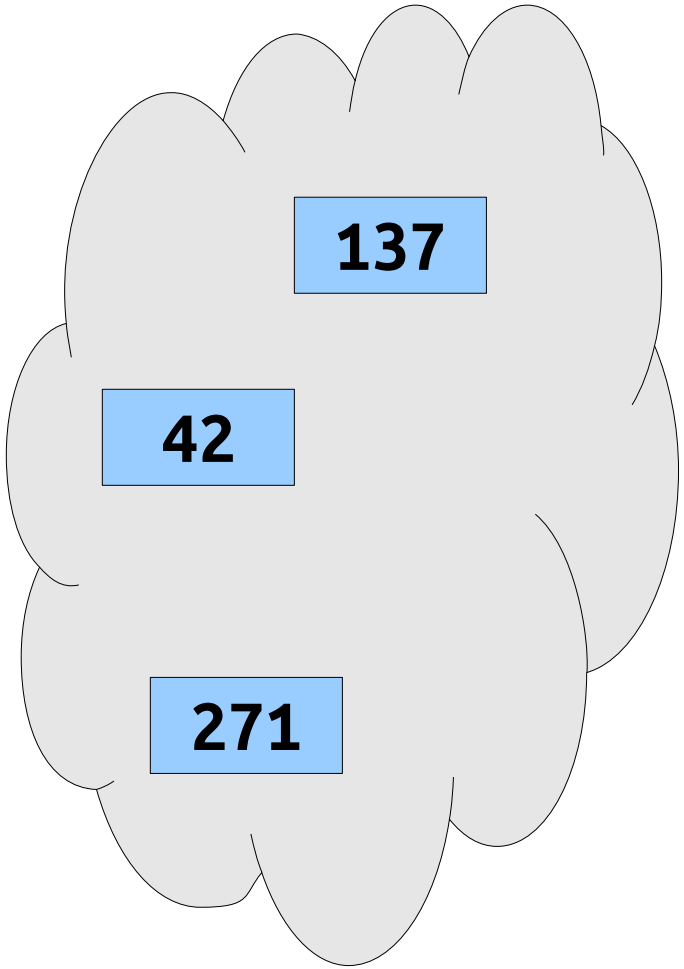
- You may find it helpful to interpret += as "ensure this item is there" and -= as "ensure this item isn't there."



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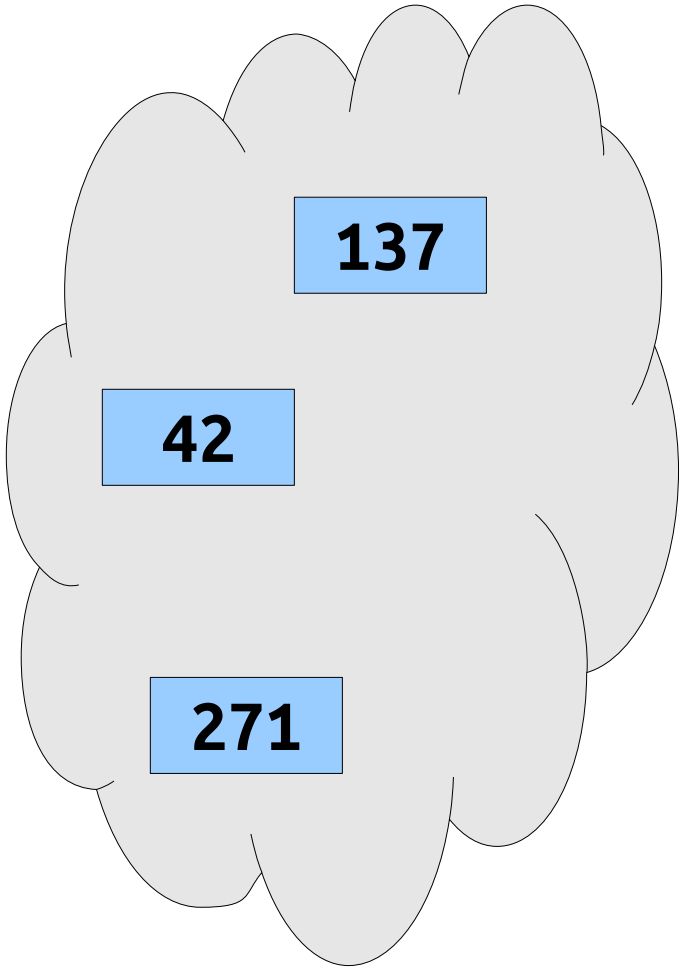

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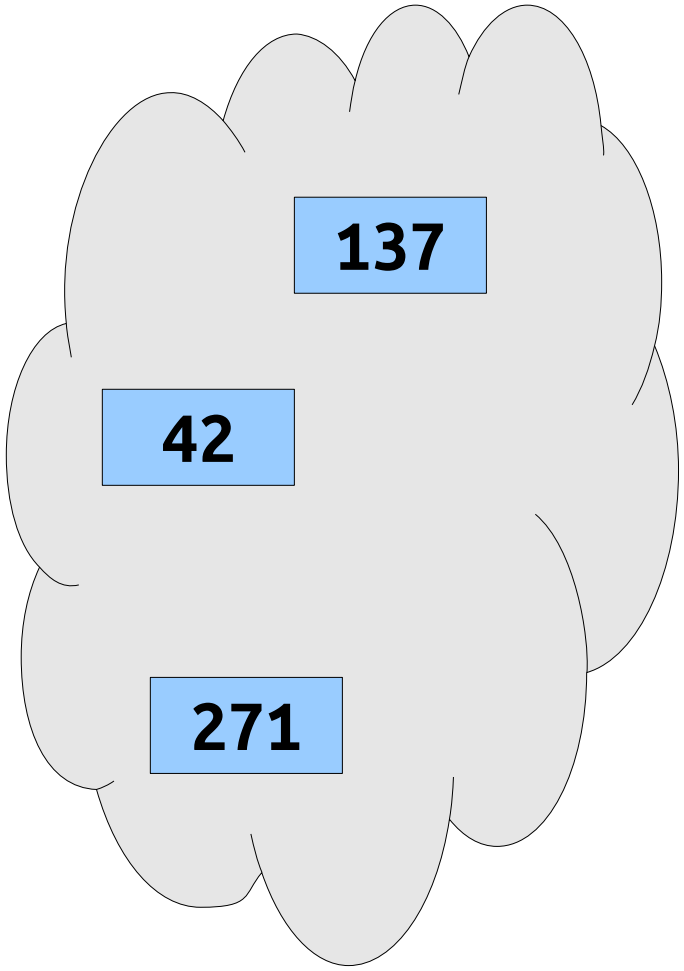


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if (values.contains(137)) {
    cout << "<(^_^)>" << endl;
}
```

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- You can loop over the contents of a set with a range-based **for** loop.

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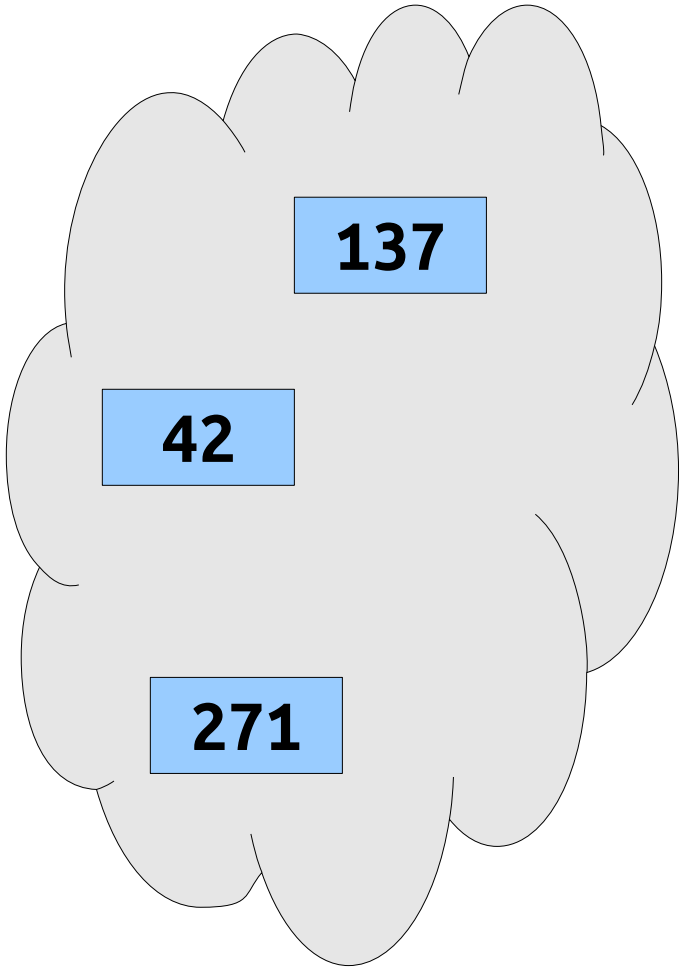

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- You can loop over the contents of a set with a range-based **for** loop.

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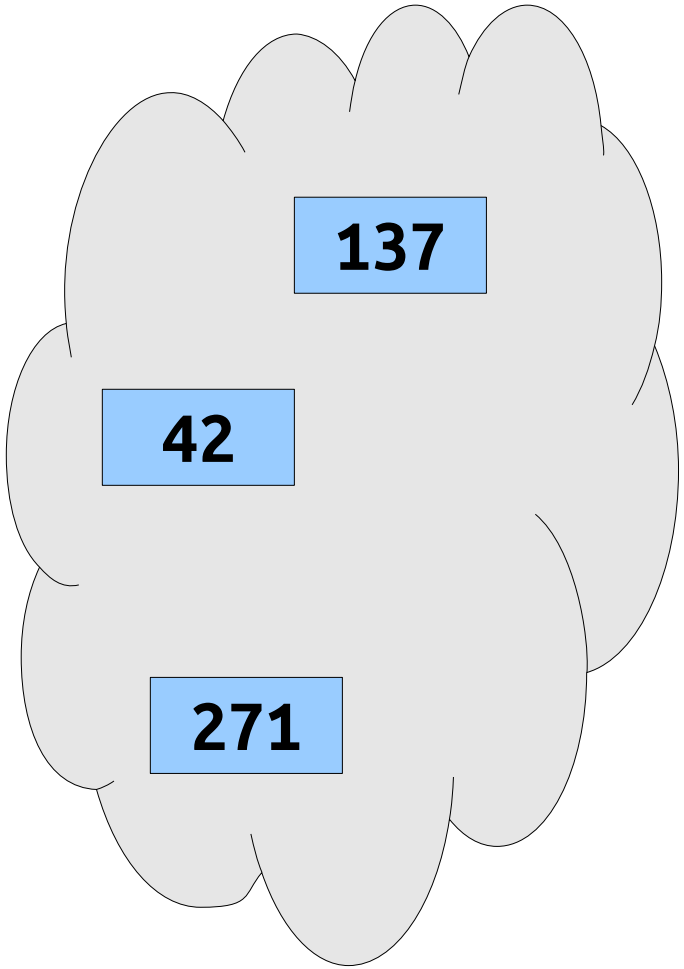
if (values.contains(137)) {
    cout << "<(^_^)>" << endl;
}

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



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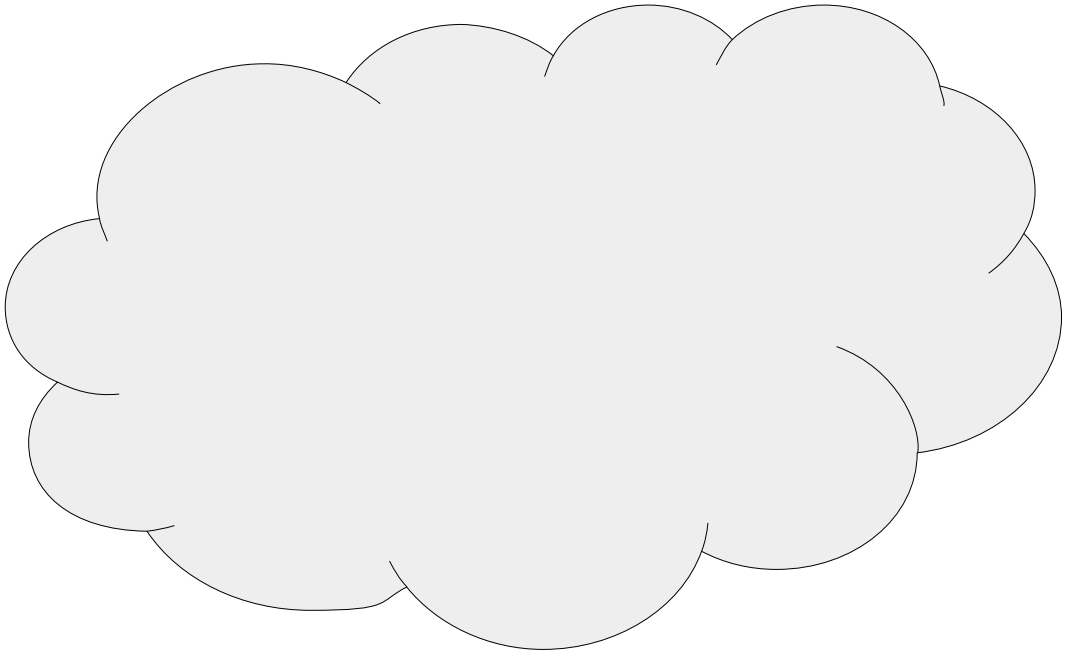

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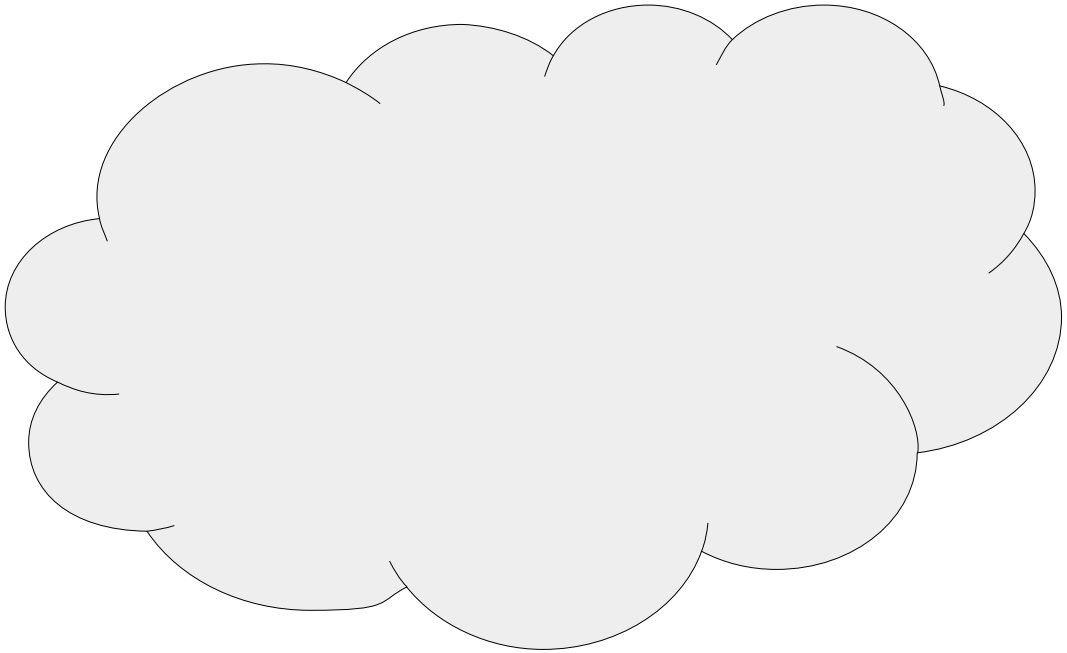

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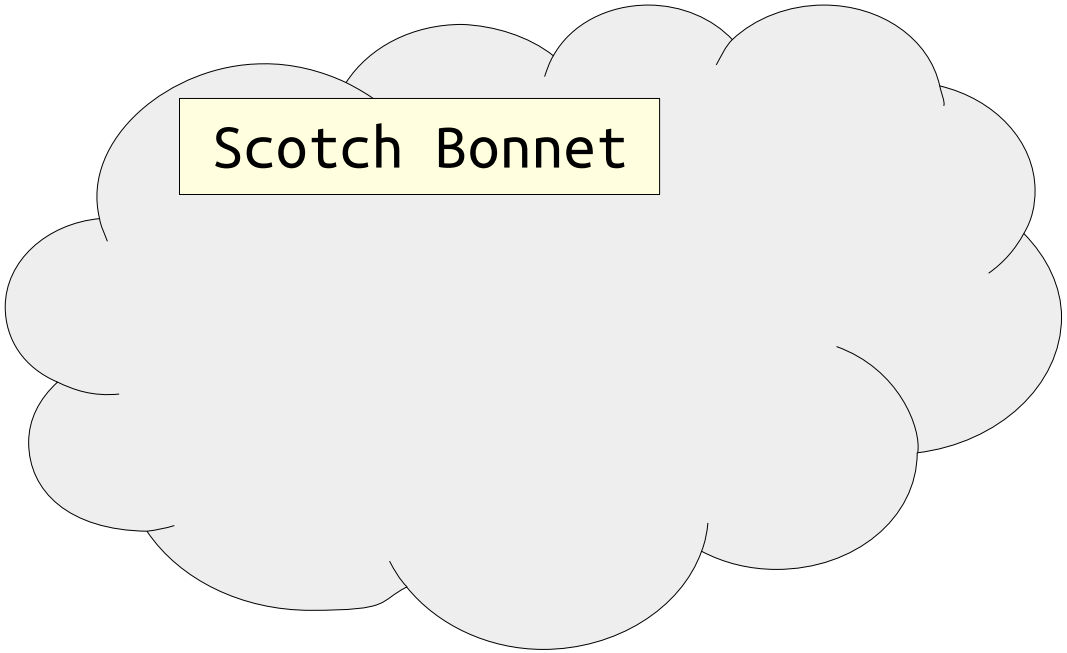


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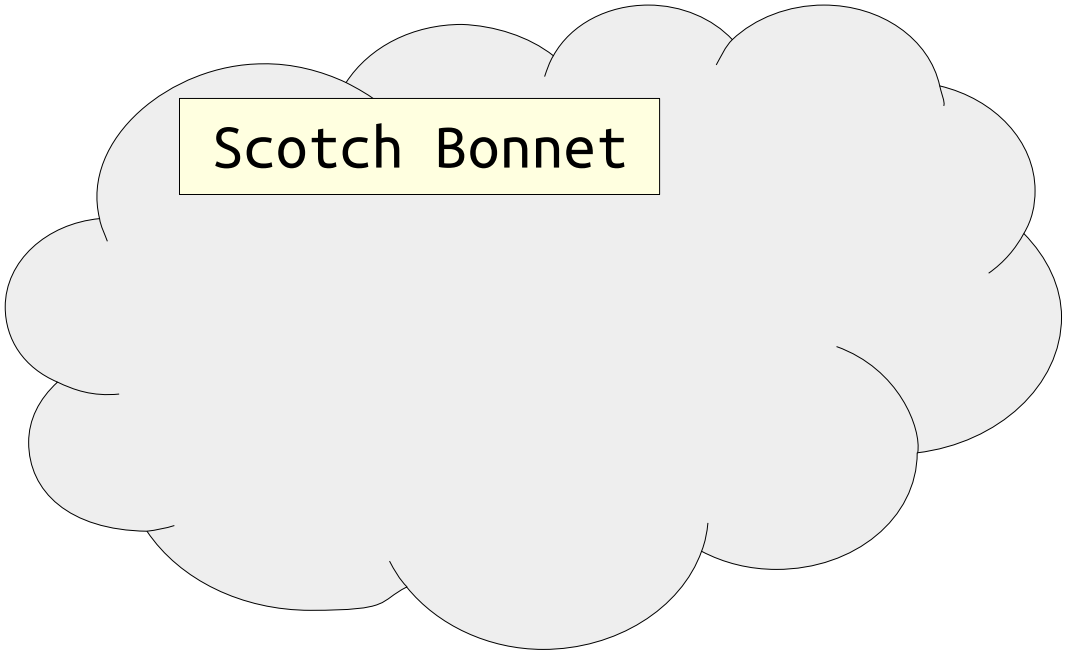


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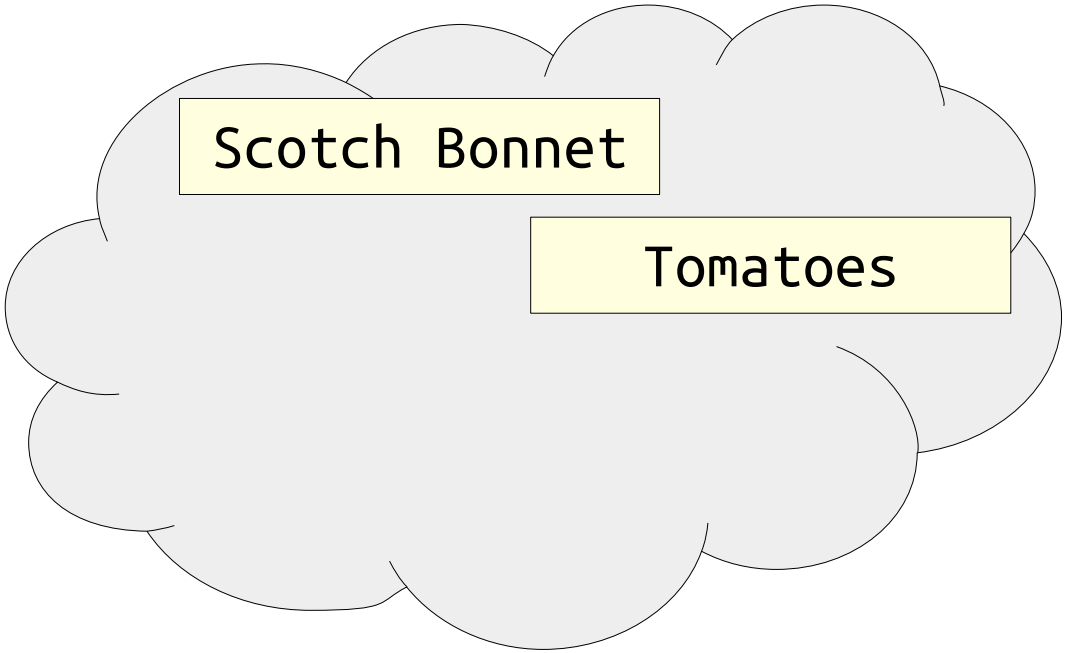


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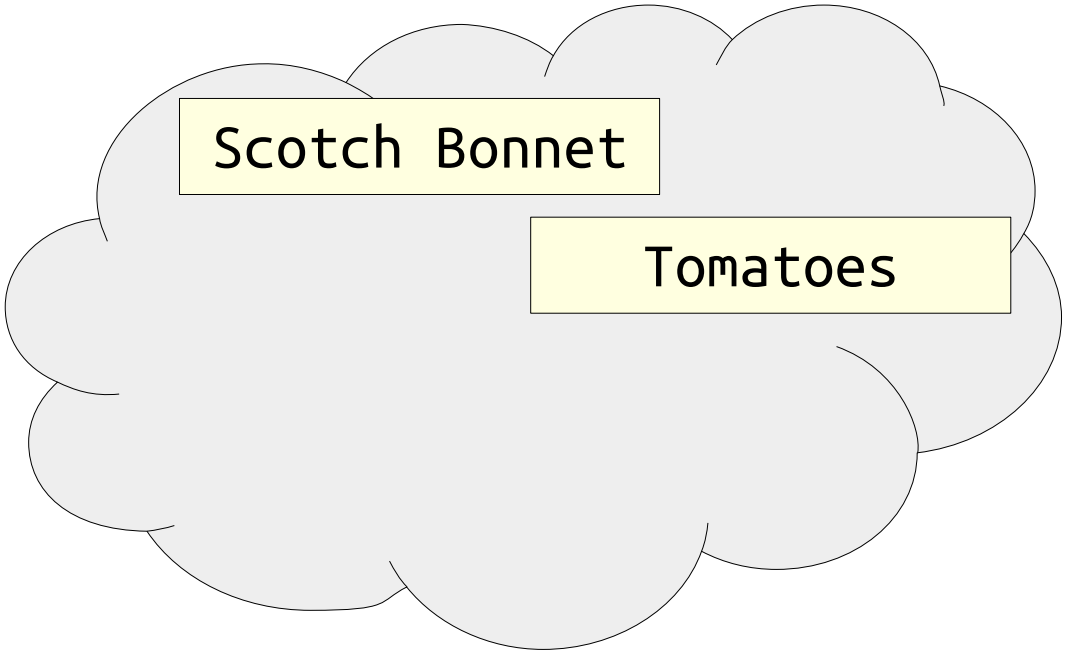


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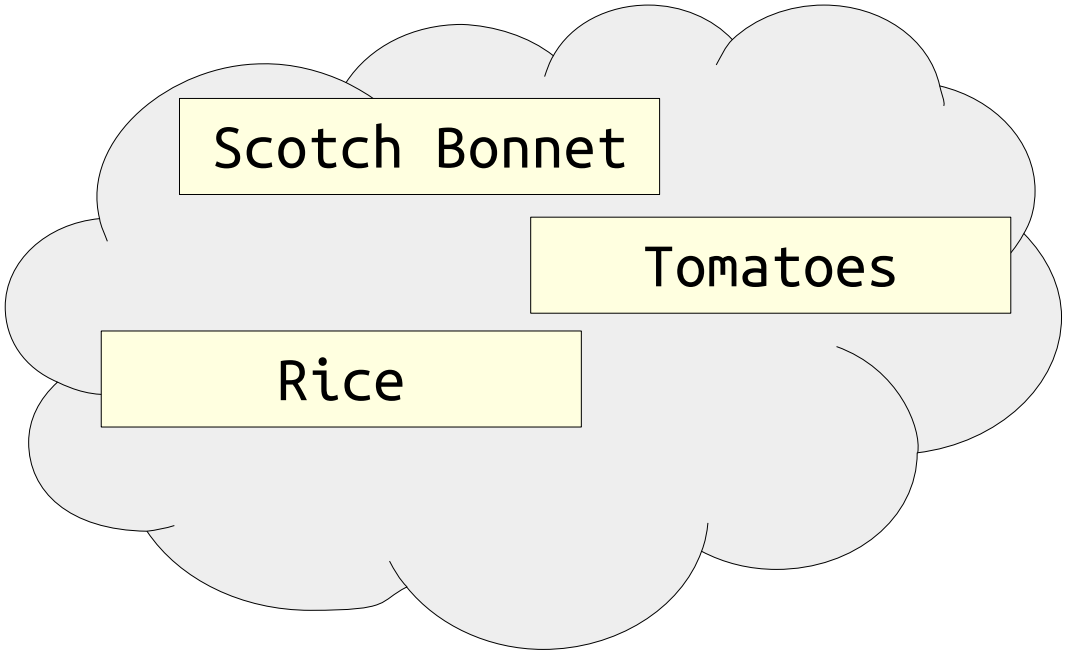


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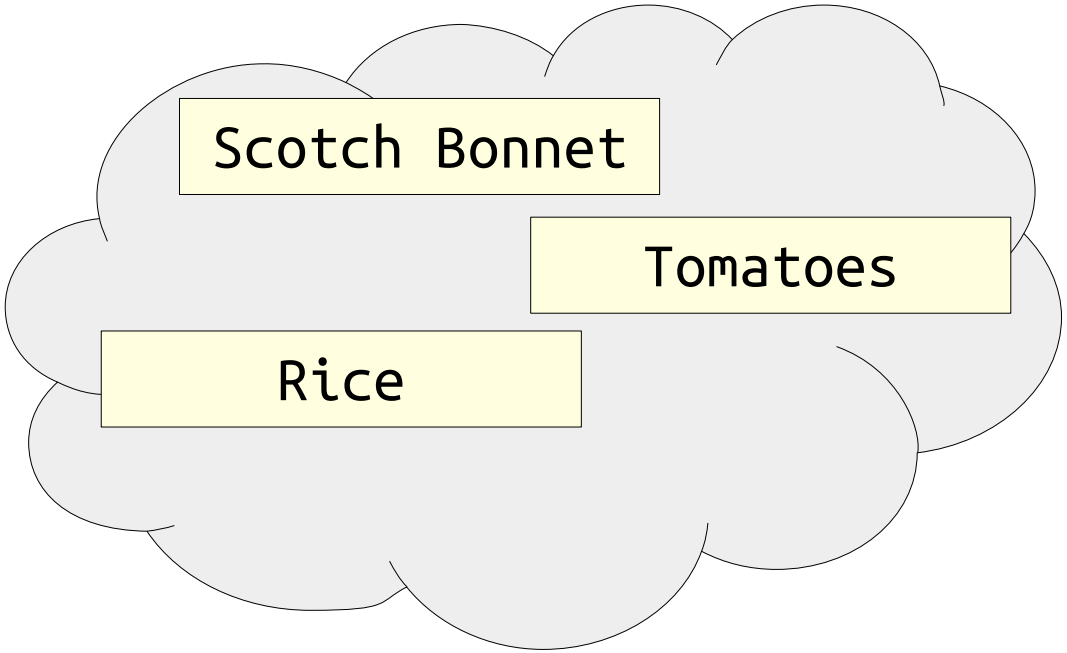


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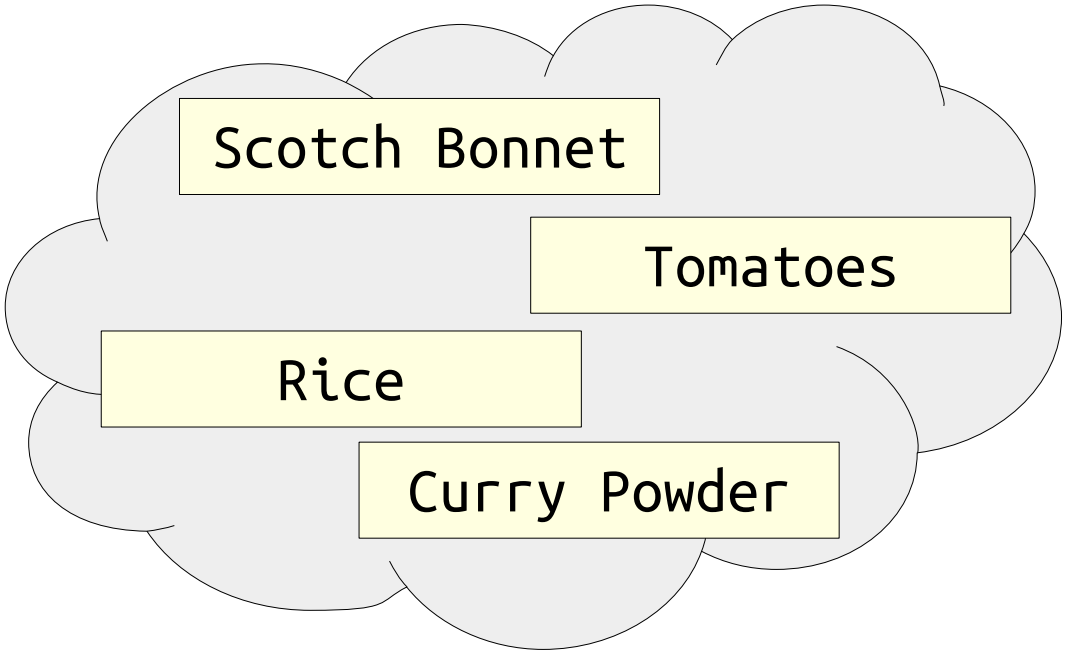


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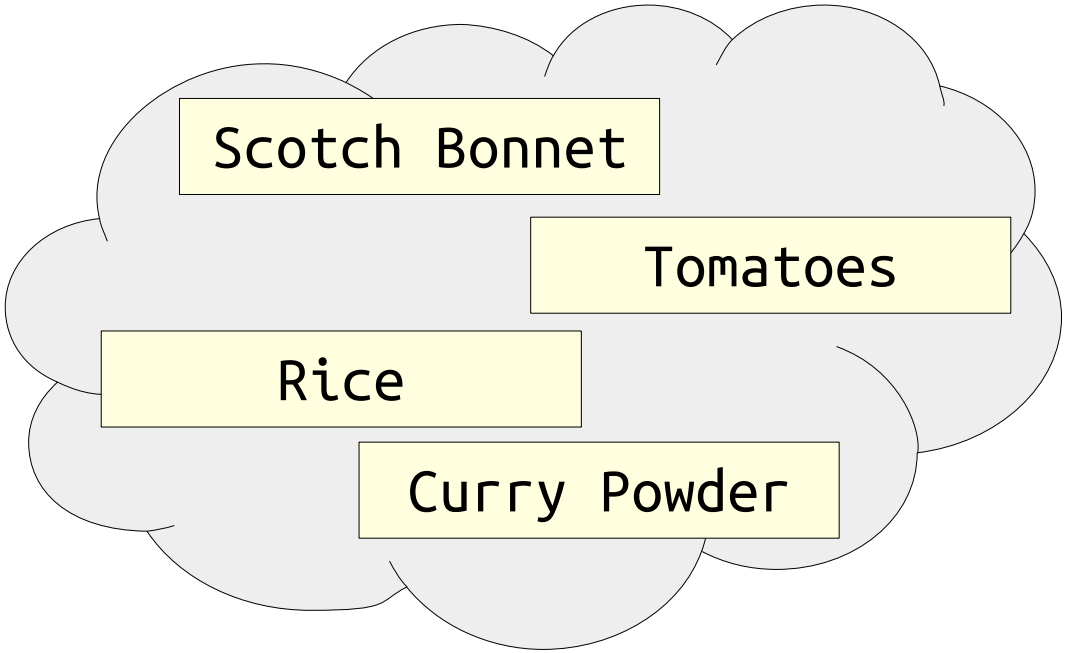


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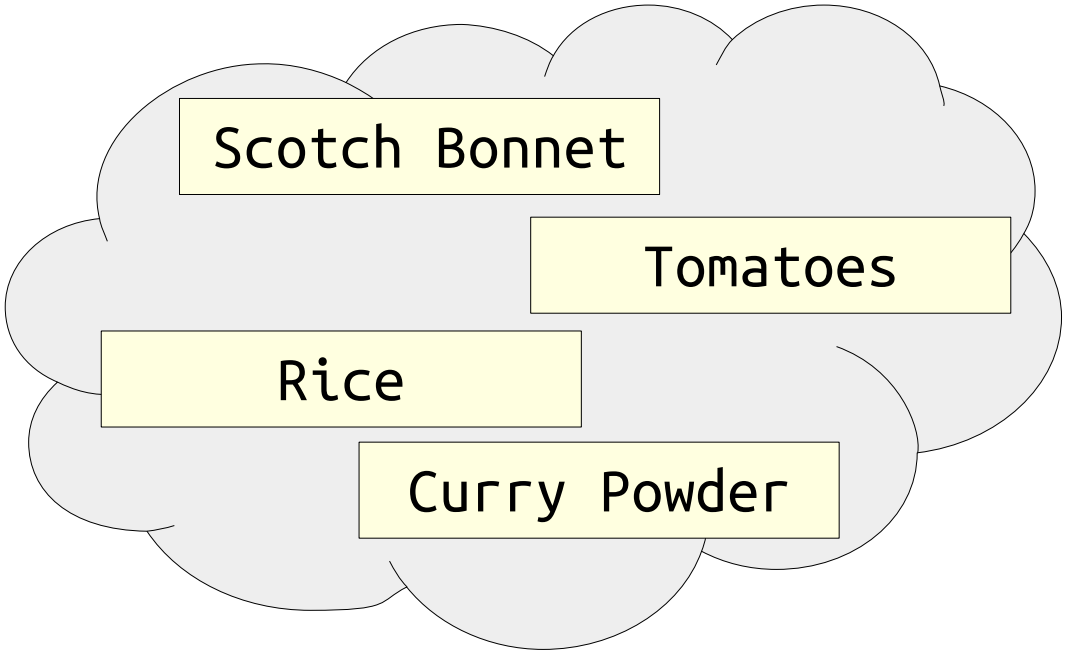
- A shopping list is a great place to use a `Set`.
- Sets ignore duplicates, so adding an existing item has no effect.
- There's no notion of "the first item on the list," which matches how you use a shopping list.
- Removing items is easy; no indices need to be adjusted.

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toBuy += "Rice";
toBuy += "Curry powder";
toBuy += "Rice"; // Okay!
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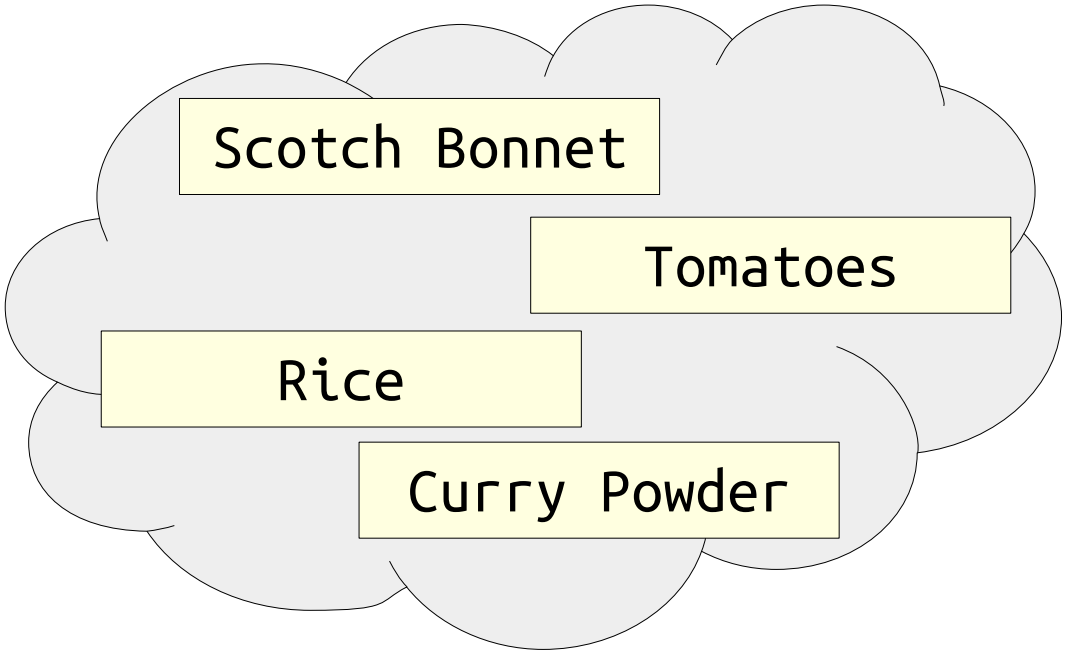


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toBuy -= "Tomatoes"; // Clearer!
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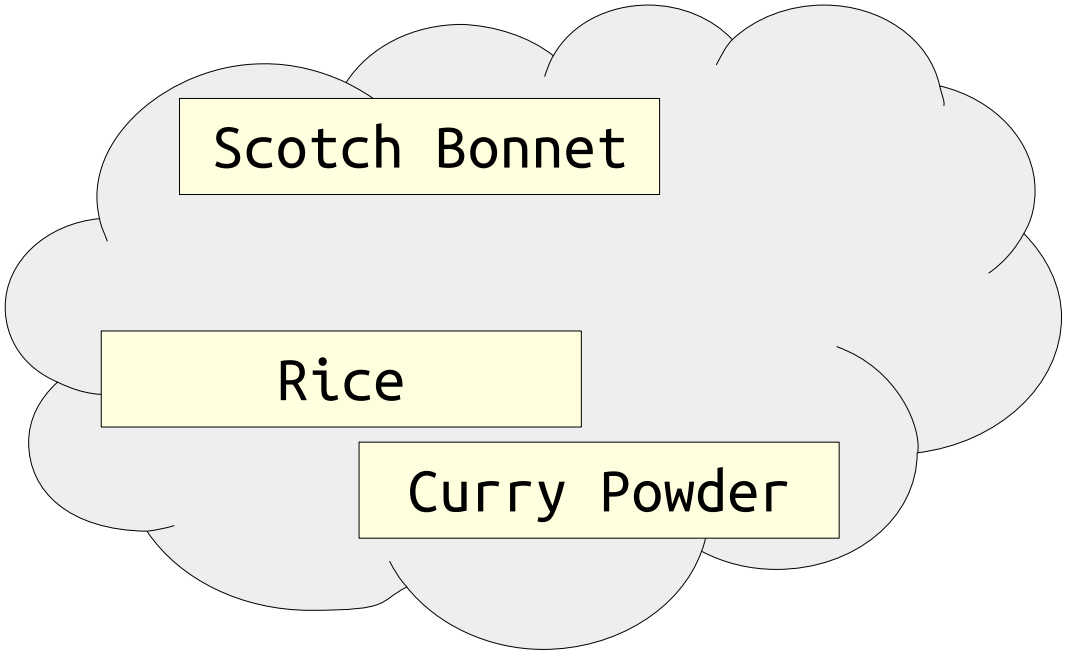


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Operations on `Set`s

- 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!

Map

Map

- The `Map` class represents a set of key/value pairs.
  - 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;
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Map<string, int> heights;

heights["Serbia"] = 153;
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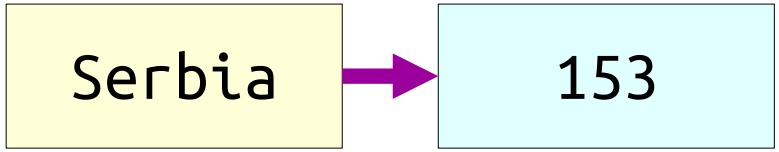


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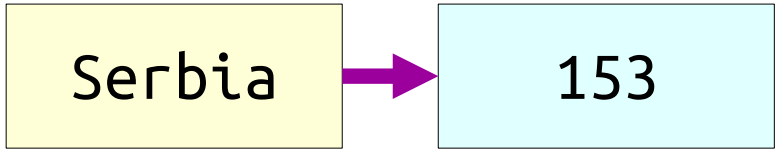


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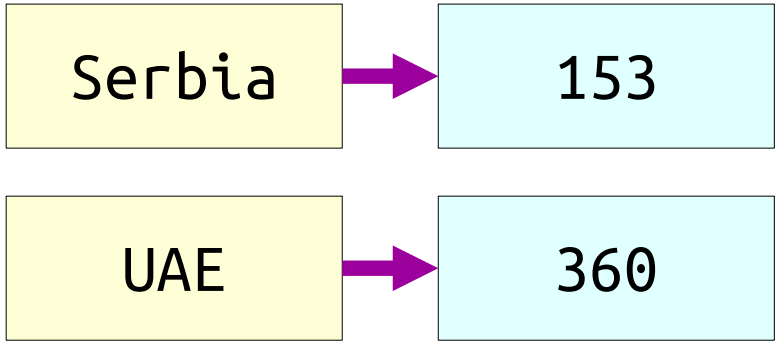


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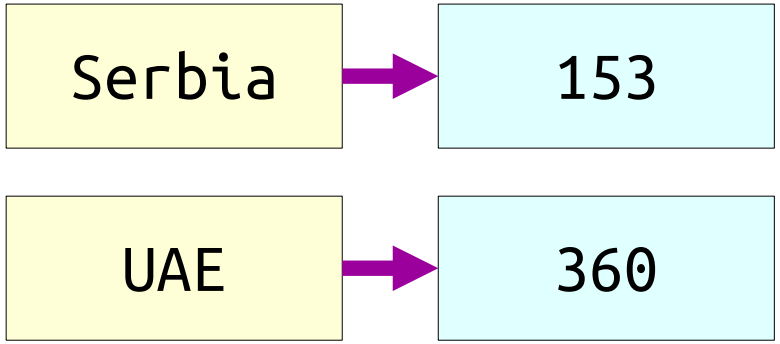


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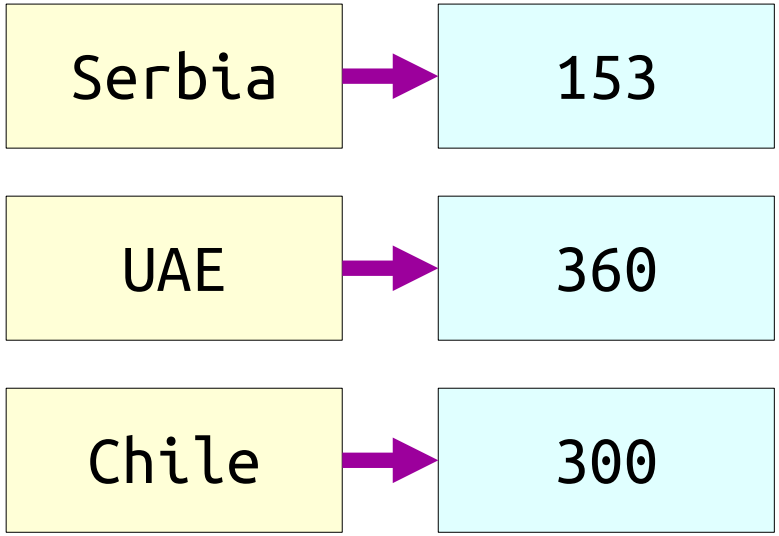


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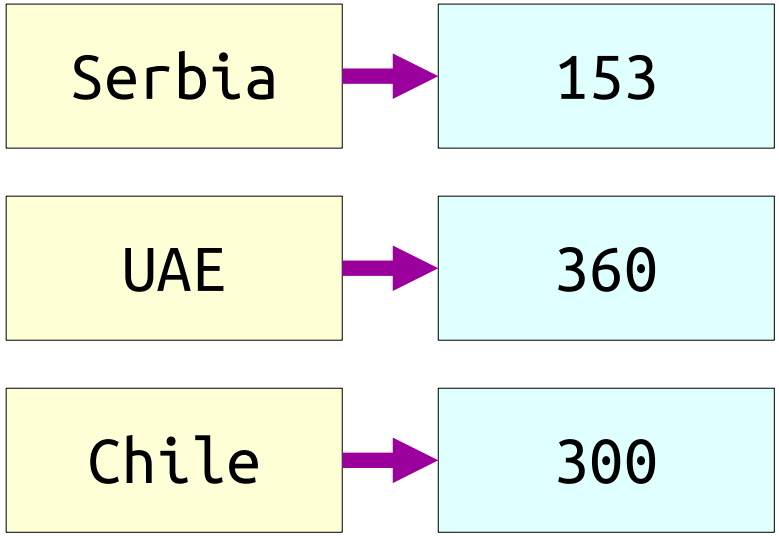


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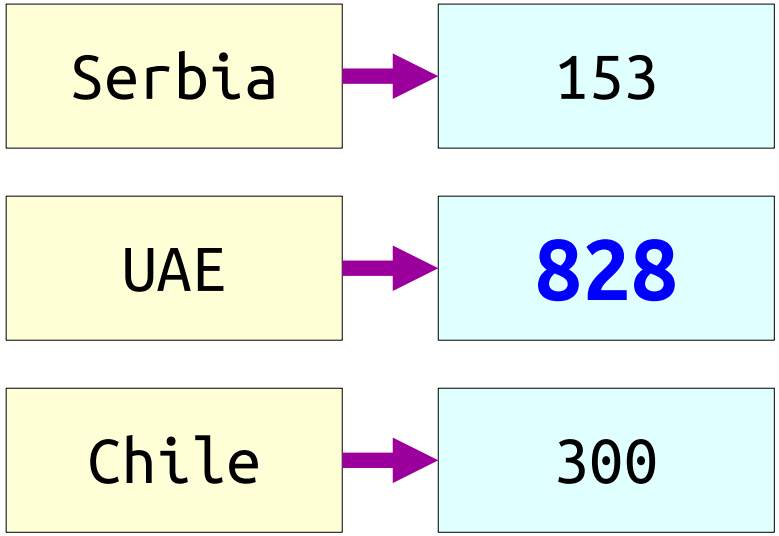


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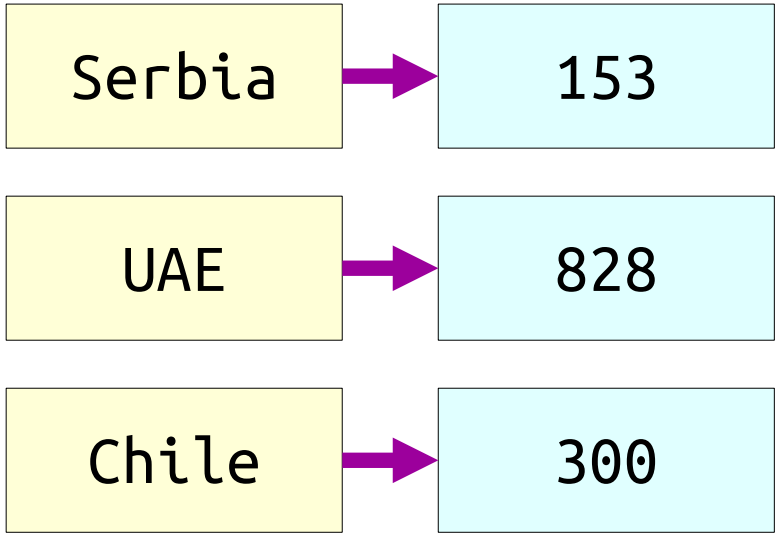


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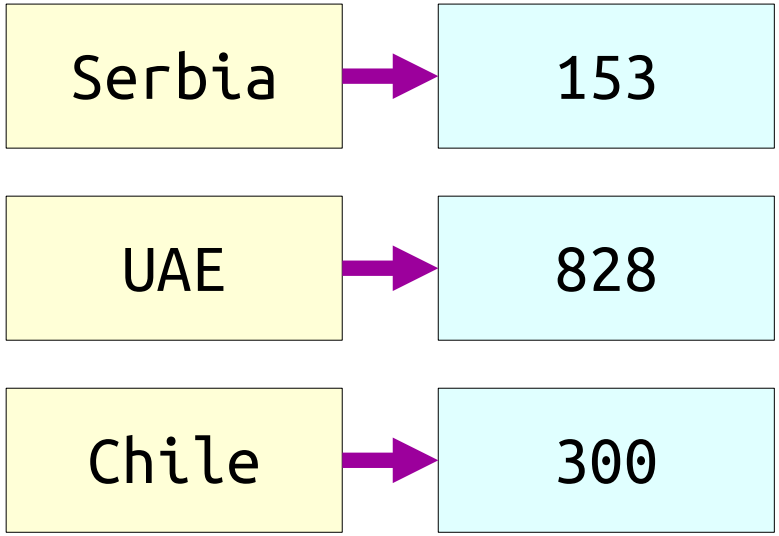


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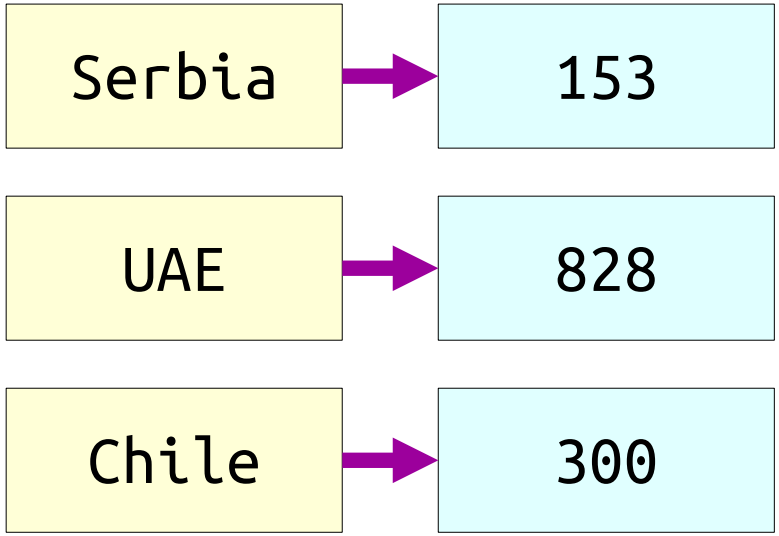


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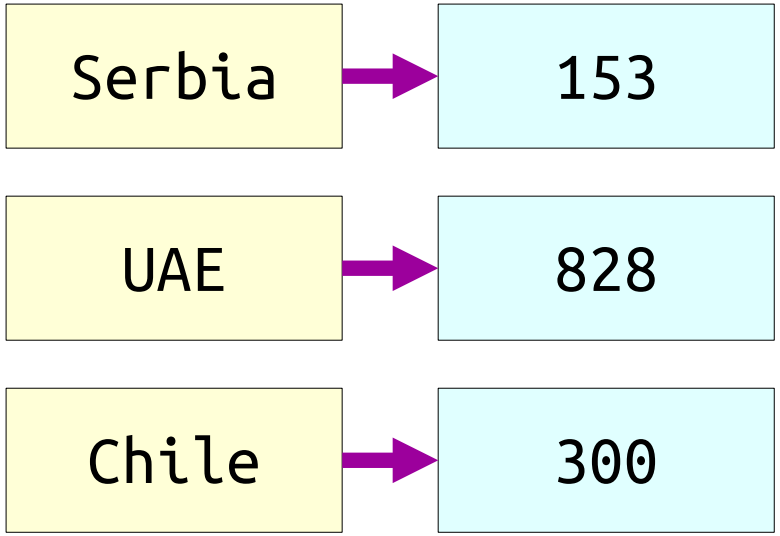
cout << heights["Chile"] << endl;
```

Map

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



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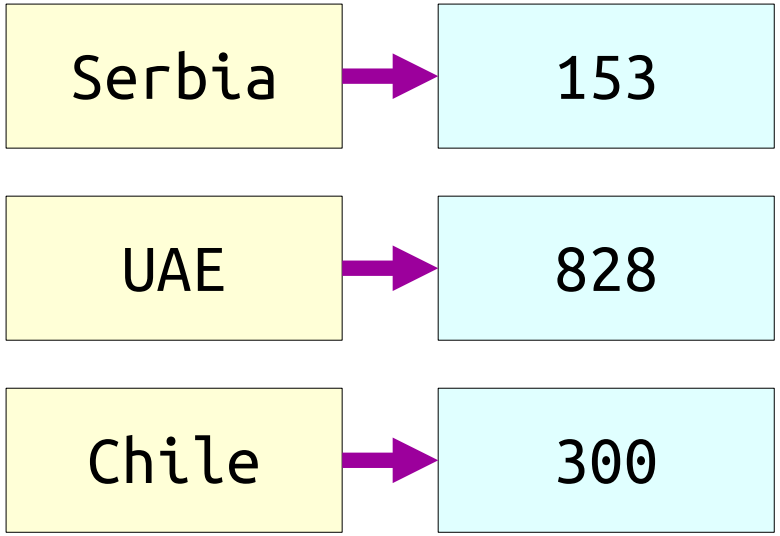


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for (string key: heights) {
   cout << heights[key] << endl;
}
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Map

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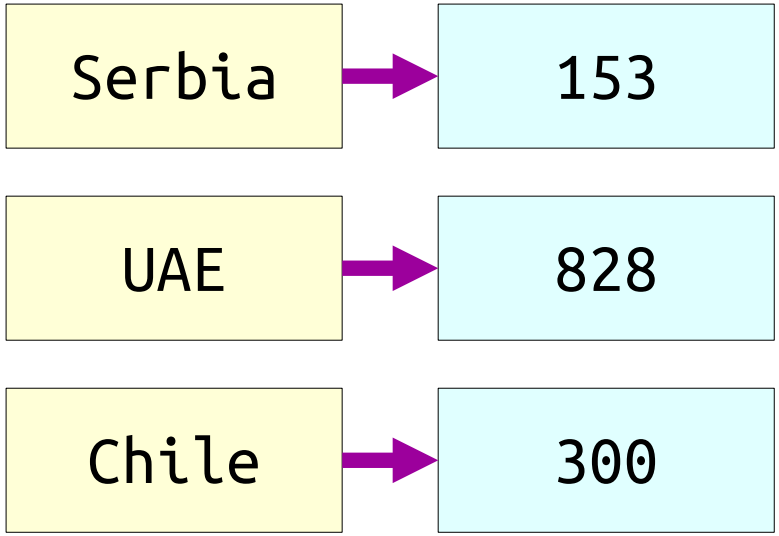


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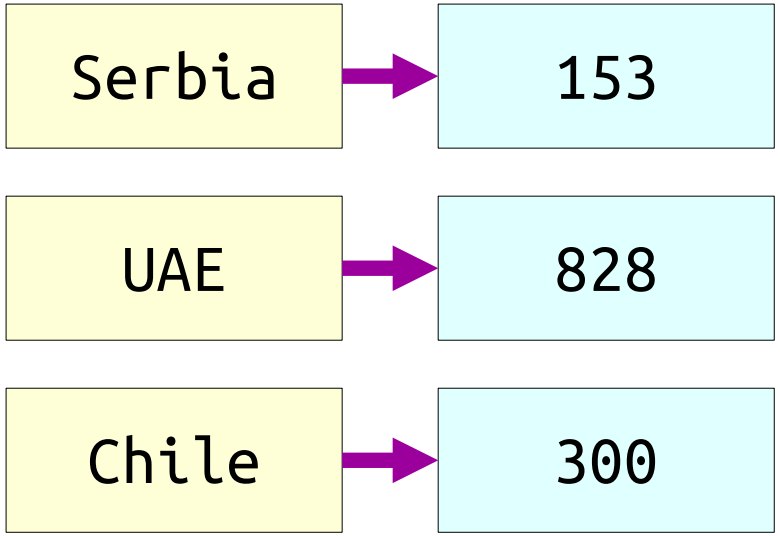


```
for (string key: heights) {
    cout << heights[key] << endl;
}

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

`Map` Autoinsertion

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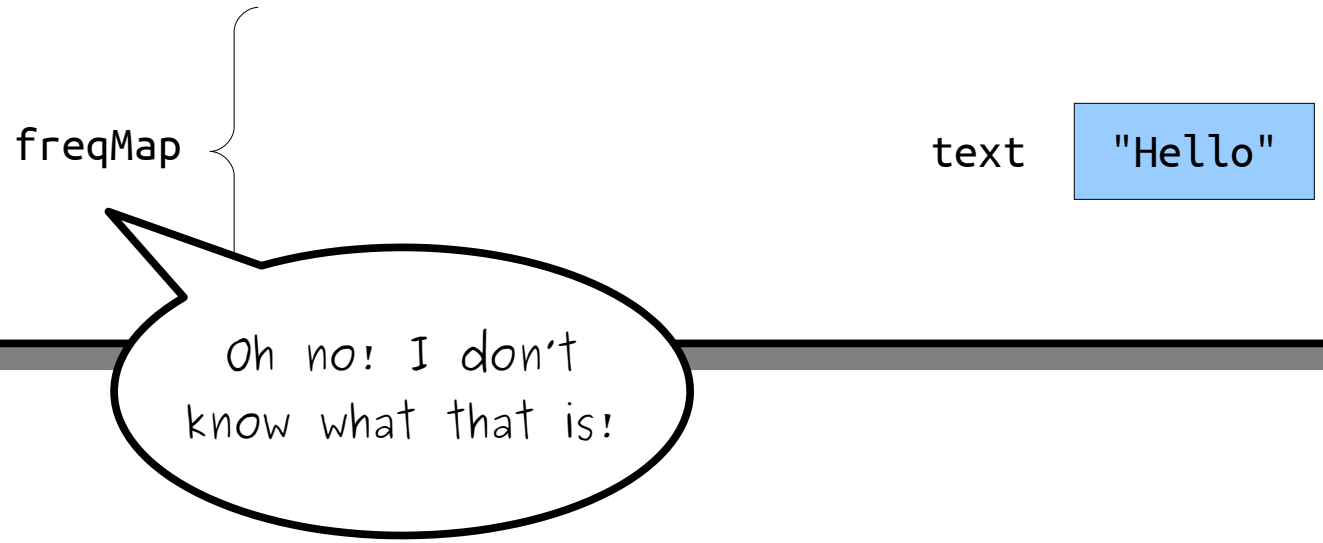

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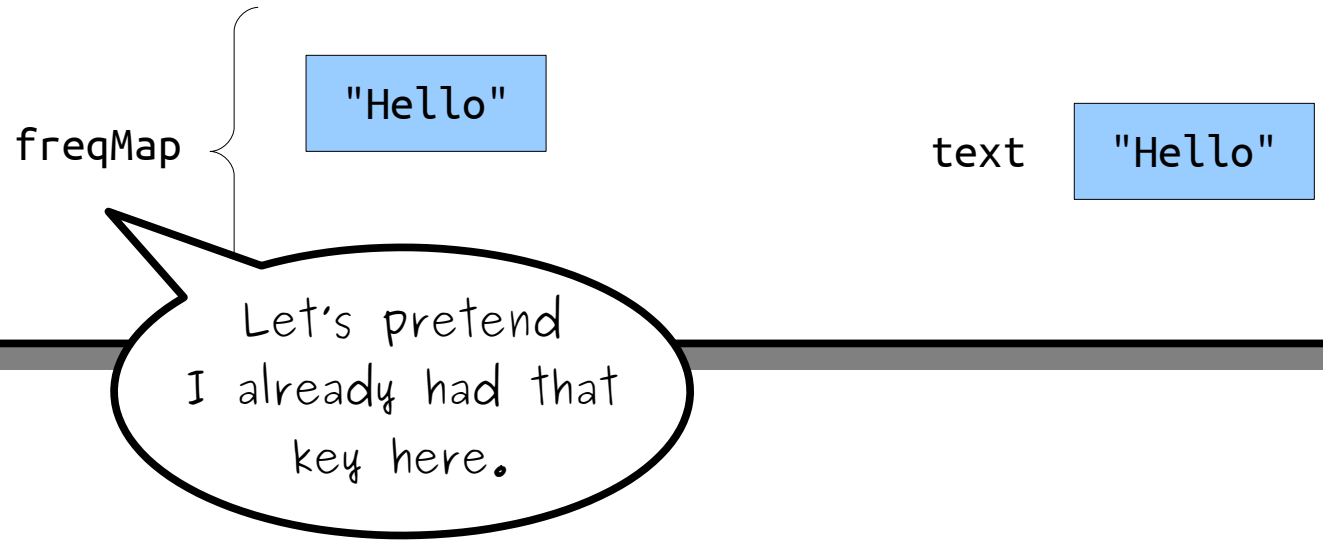

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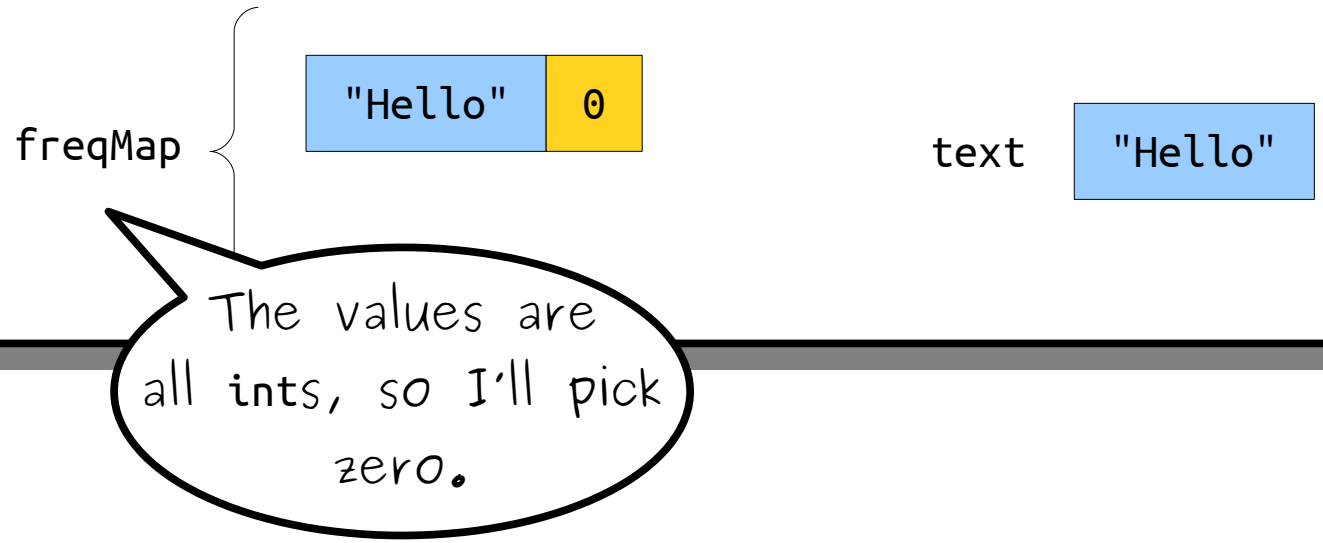

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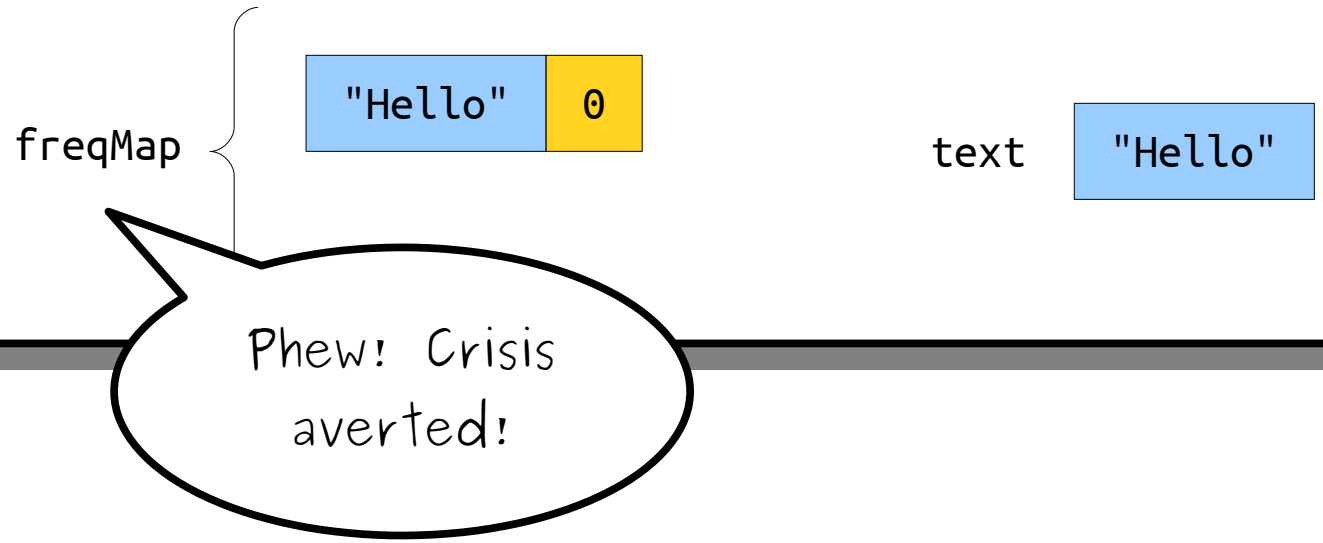

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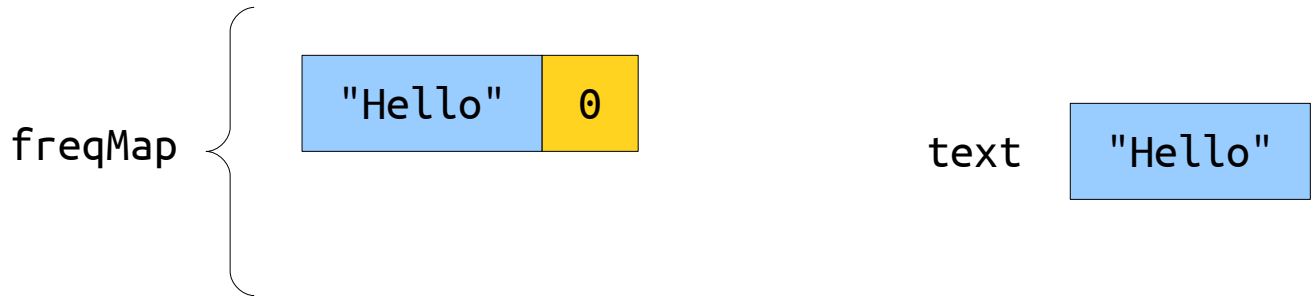

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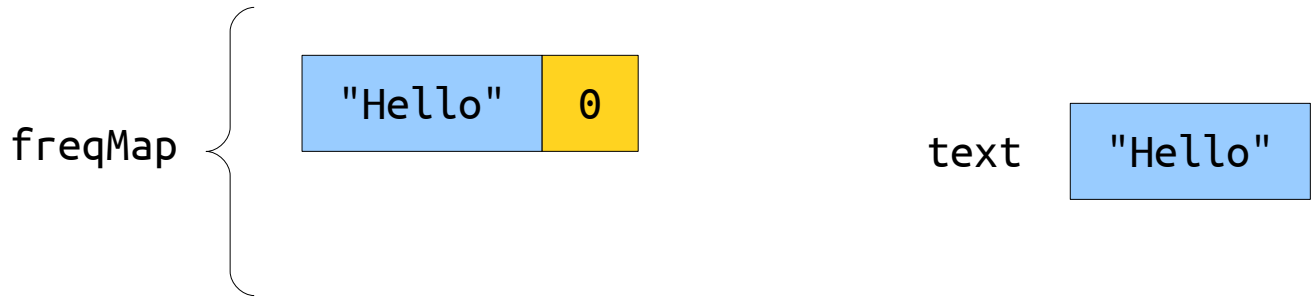

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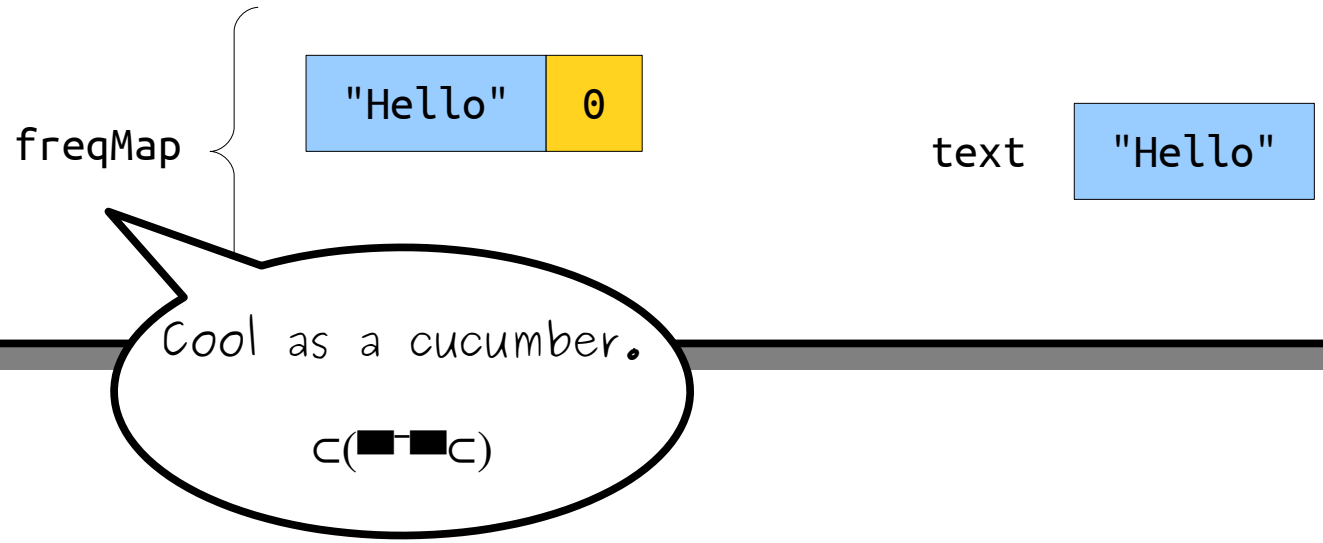

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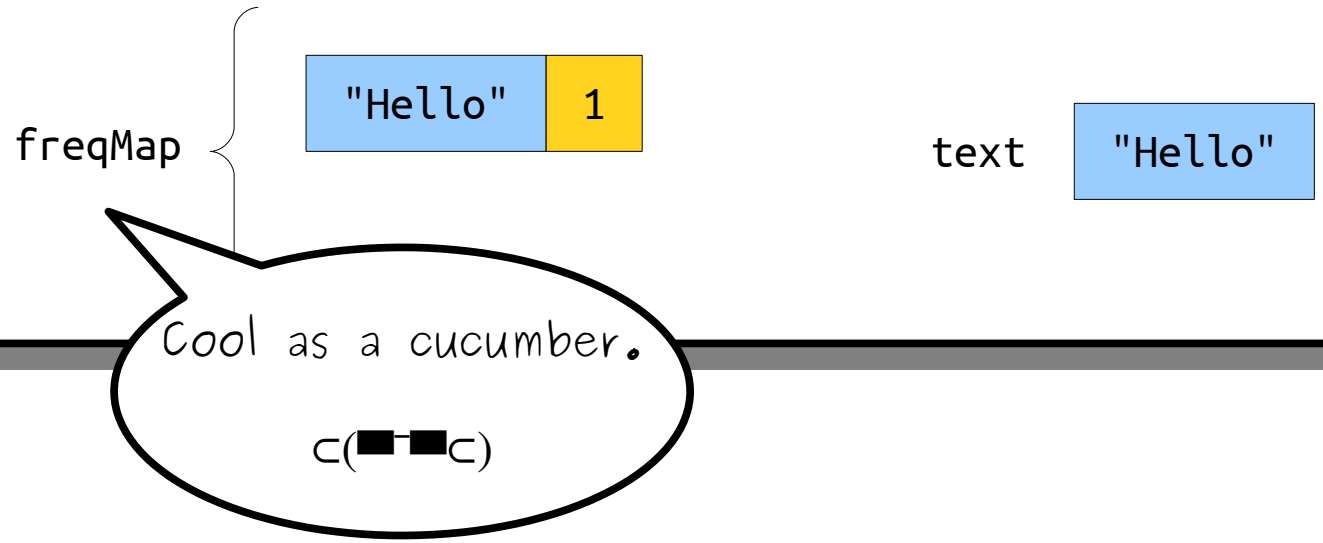

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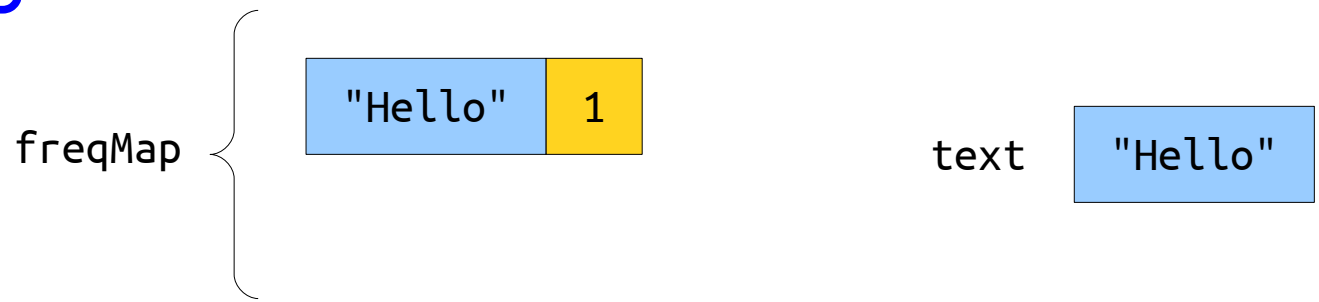

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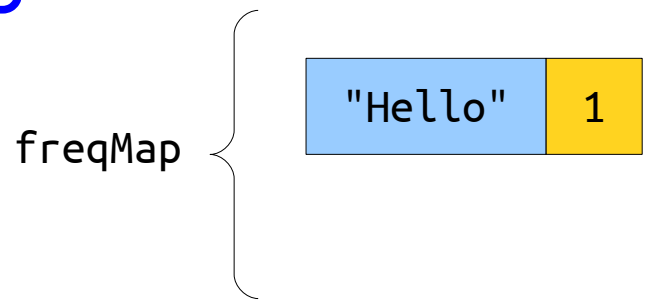

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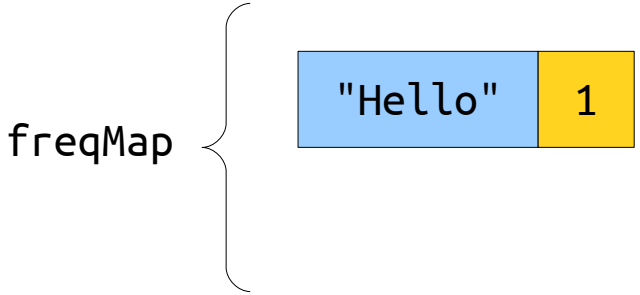

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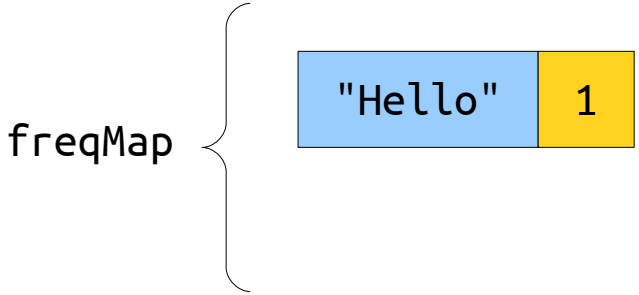

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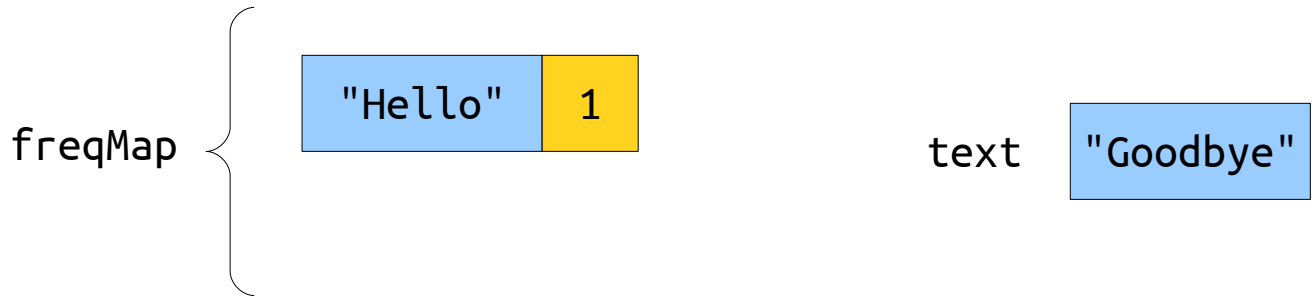

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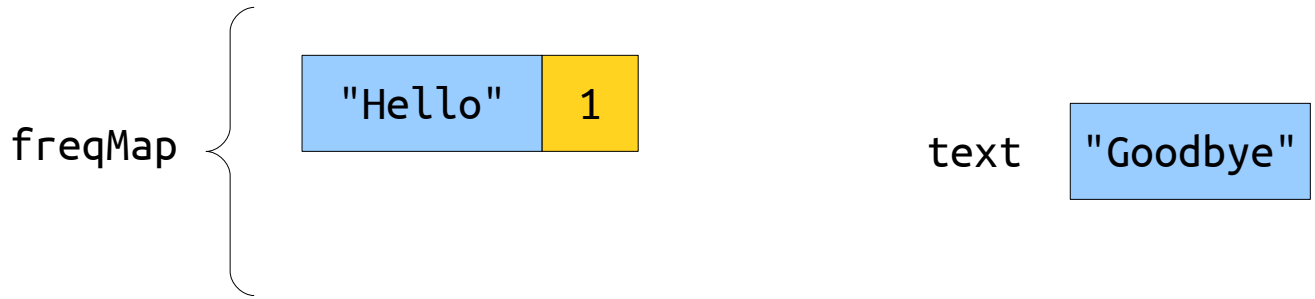

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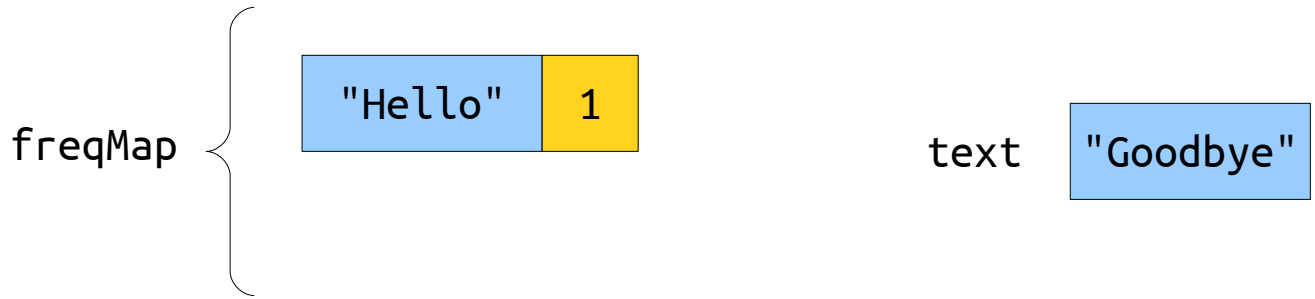
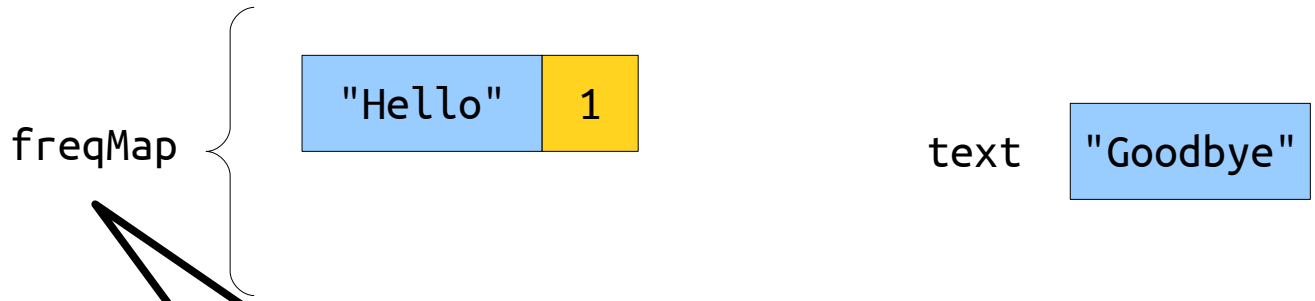


Map Autoinsertion

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



Oh no, not again!

Map Autoinsertion

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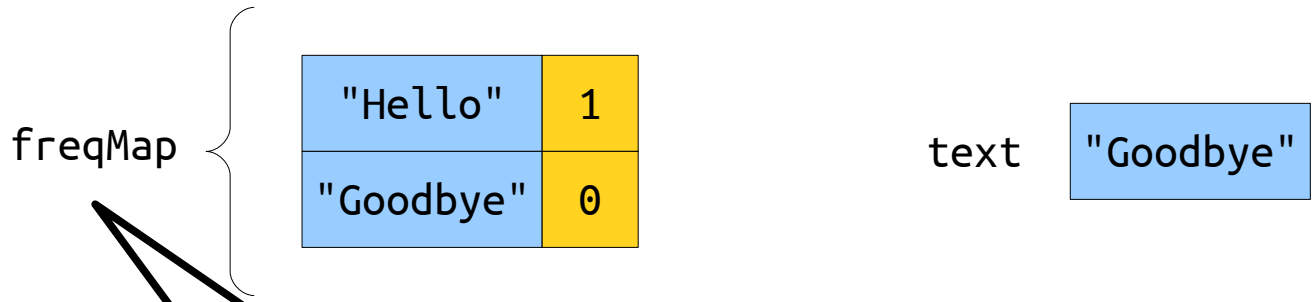
    freqMap[text]++;
}
```



I'll pretend I already had that key.

Map Autoinsertion

```
Map<string, int> freqMap;
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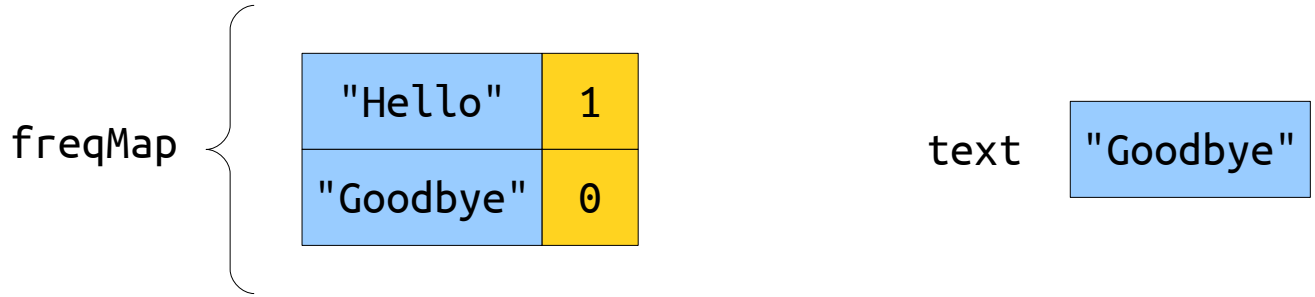

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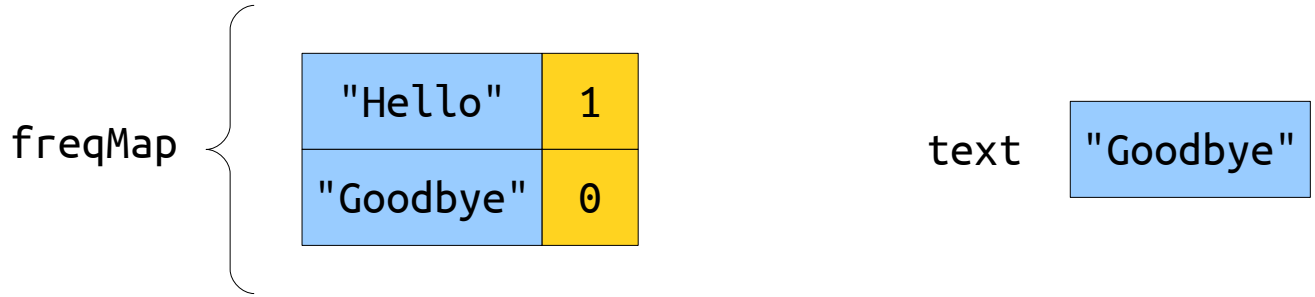

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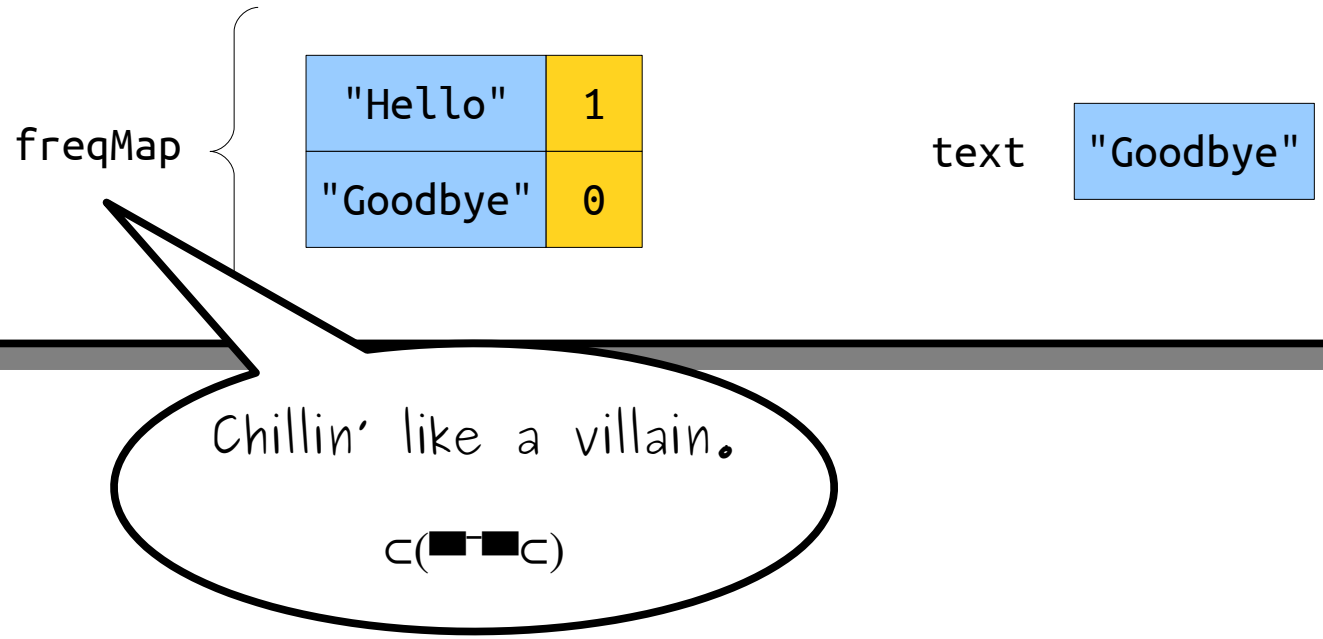

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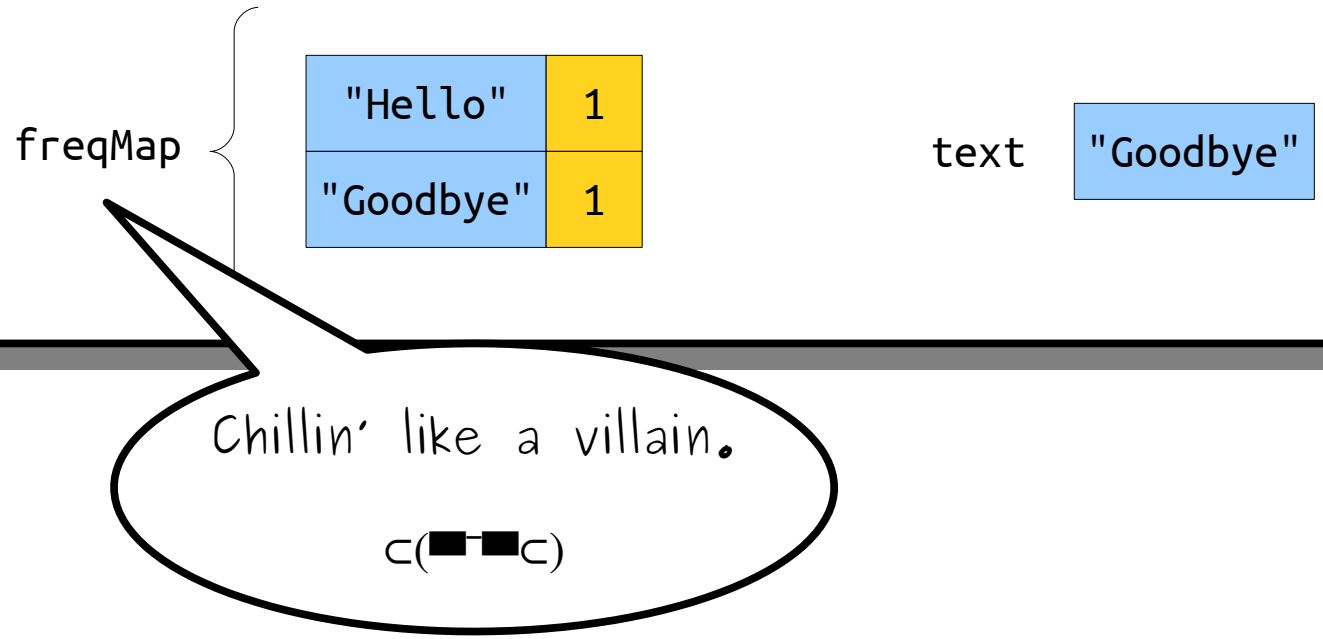

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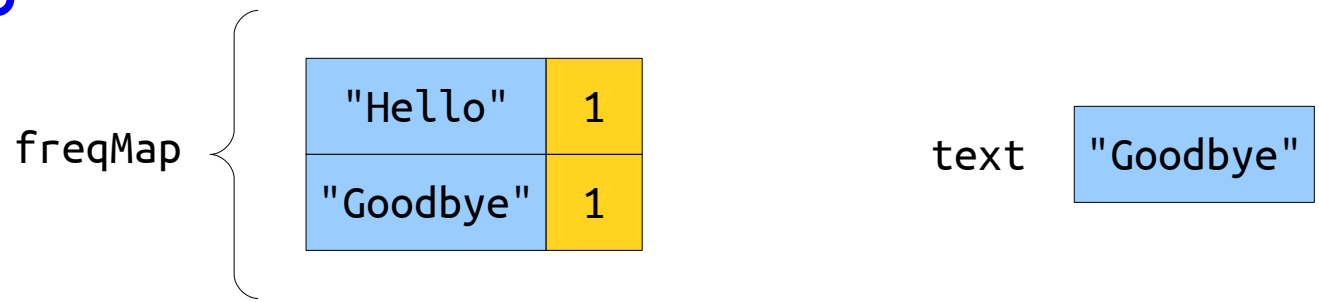

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    cout << "Times seen: " << freqMap[text] << endl;
    freqMap[text]++;
}
```

freqMap

"Hello"	1
"Goodbye"	1

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)`*

Sorting by First Letters

Map Autoinsertion

```
Lexicon english("EnglishWords.txt");

Map<char, Lexicon> wordsByFirstLetter;
for (string word: english) {
   wordsByFirstLetter[word[0]].add(word);
}
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wordsByFirstLetter

word "first"

Map Autoinsertion

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wordsByFirstLetter

word "first"

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wordsByFirstLetter

word "first"

Map Autoinsertion

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for (string word: english) {
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}
```

wordsByFirstLetter

word "first"

Oops, no f's here.

Map Autoinsertion

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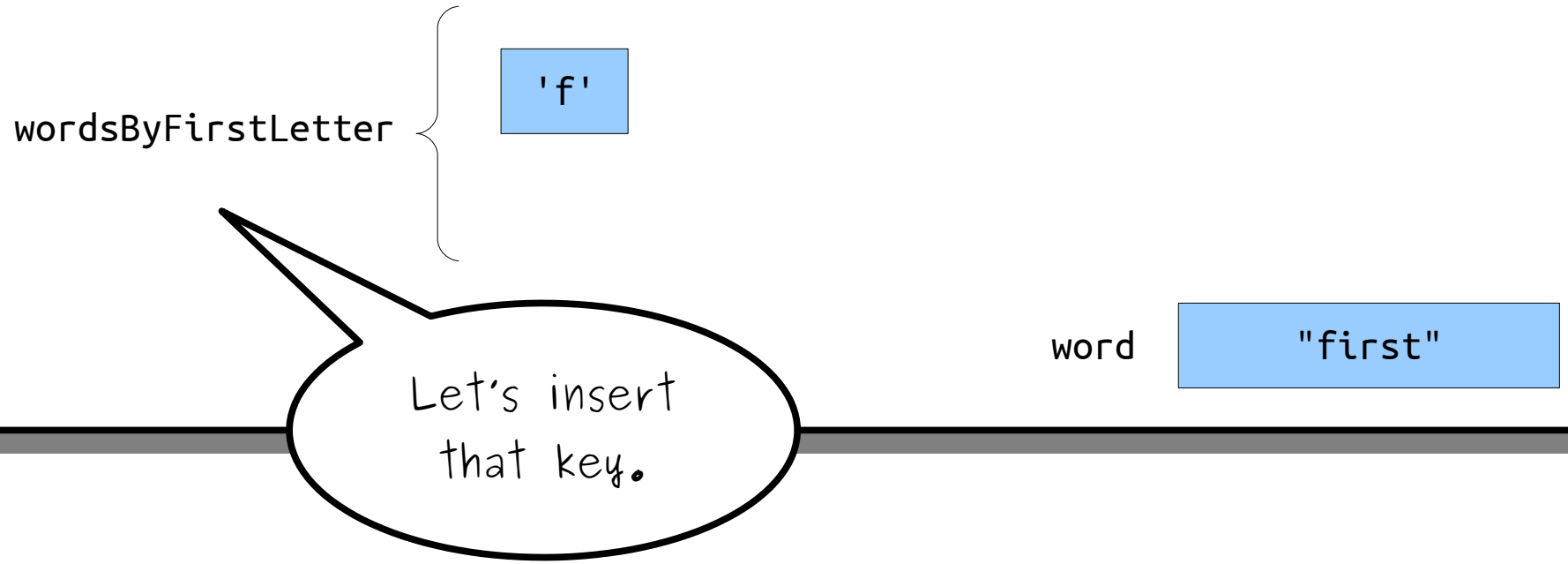
}
```



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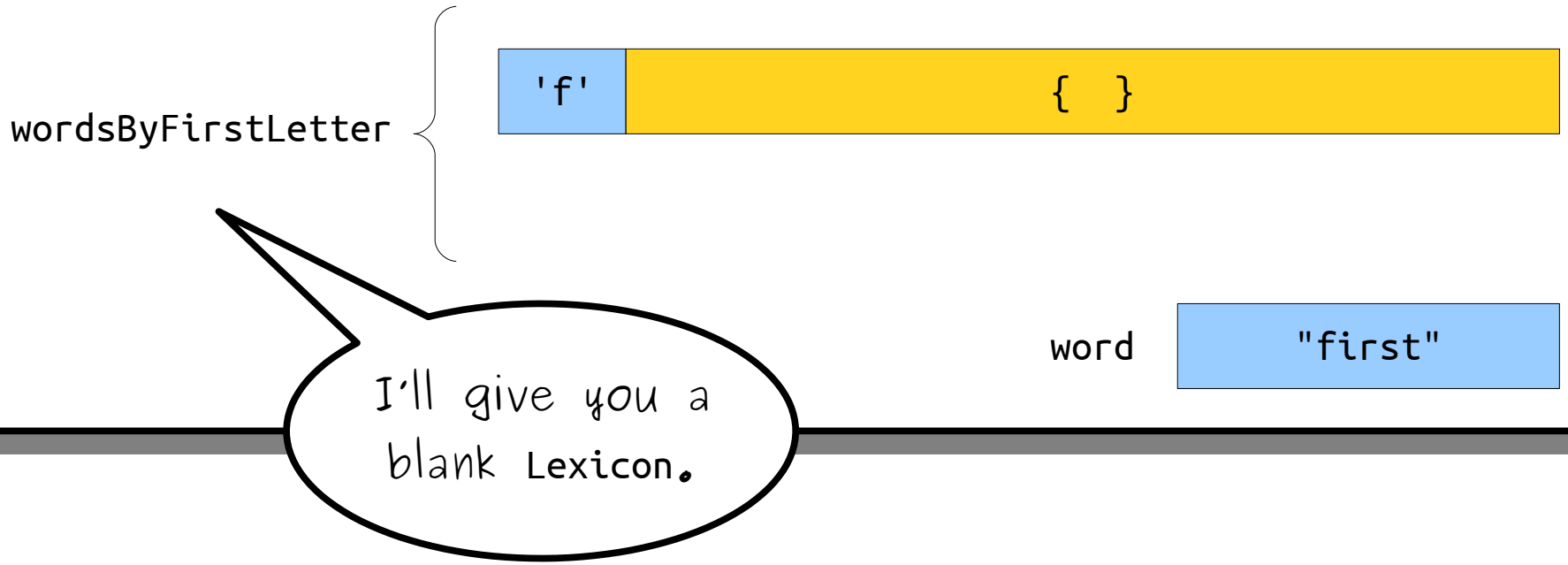

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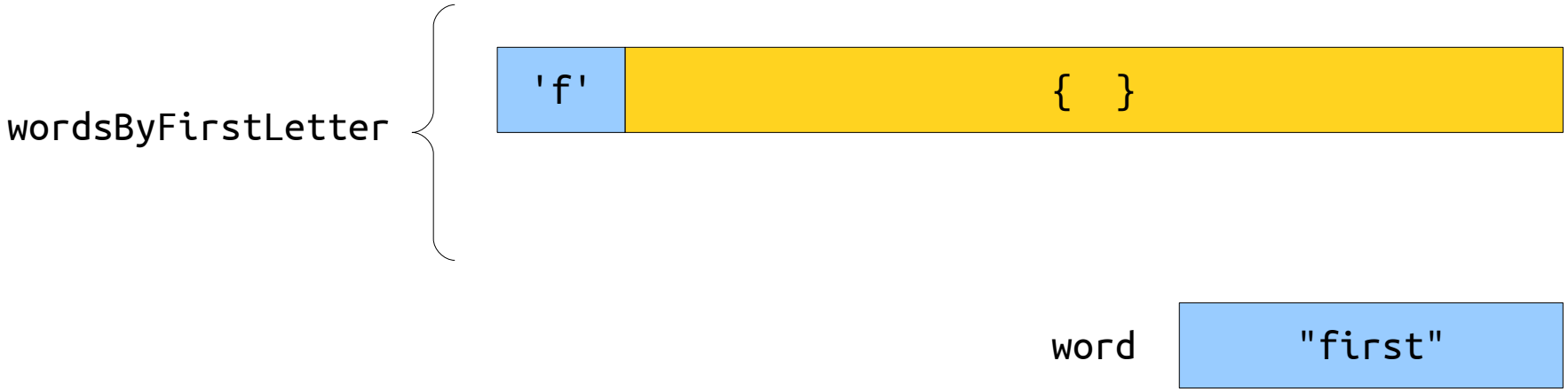

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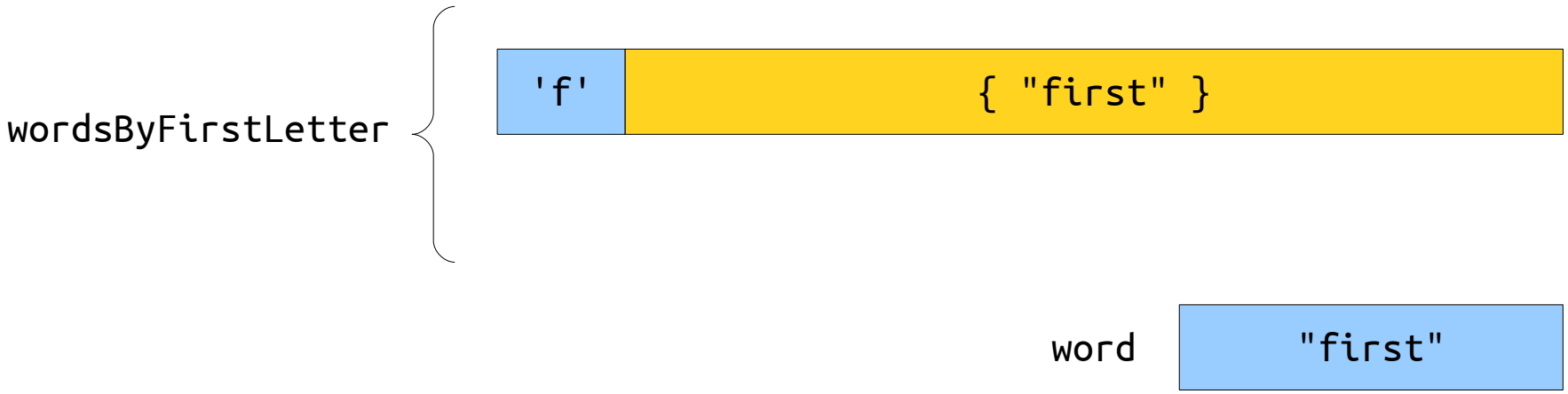

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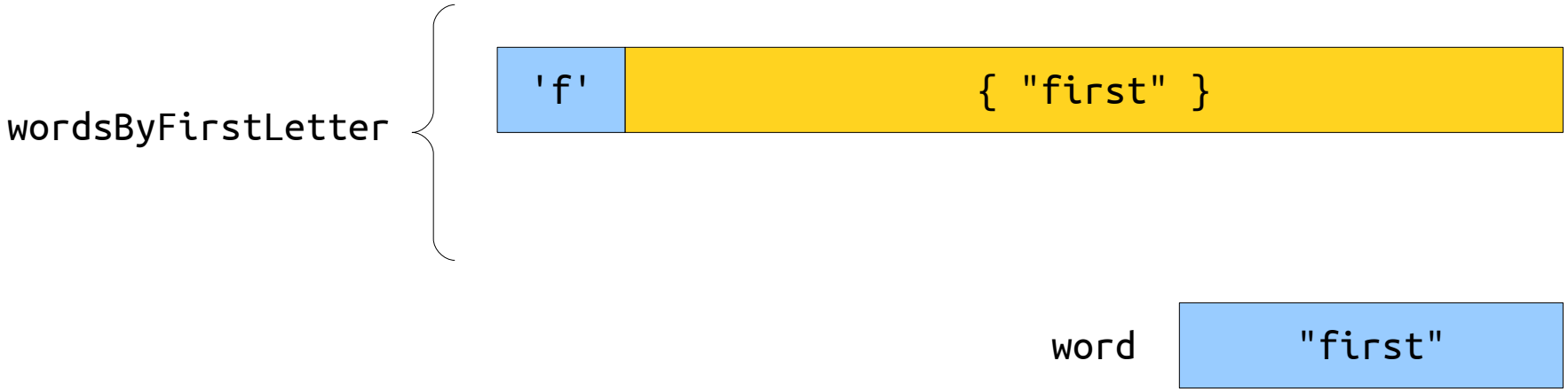

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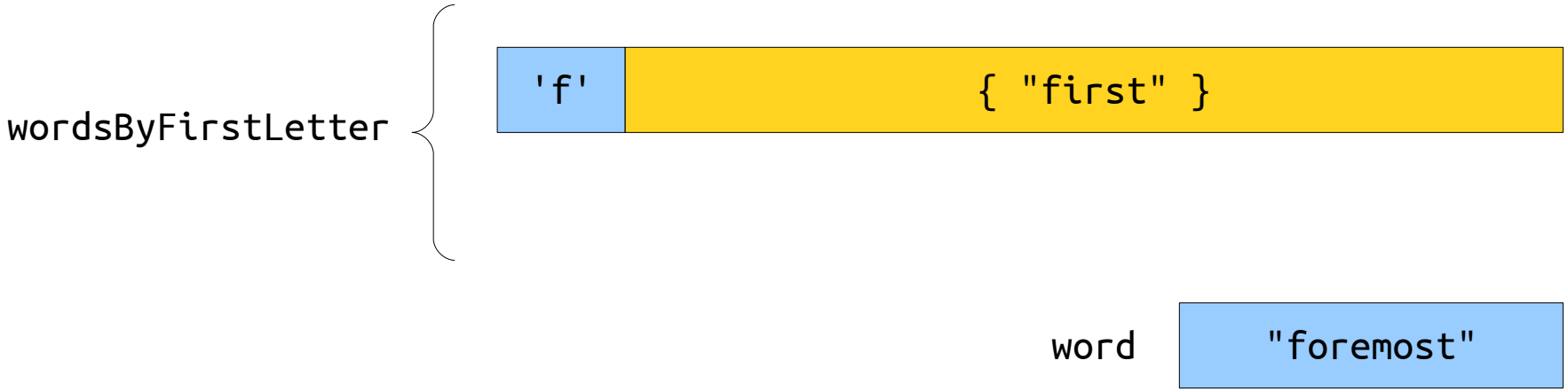

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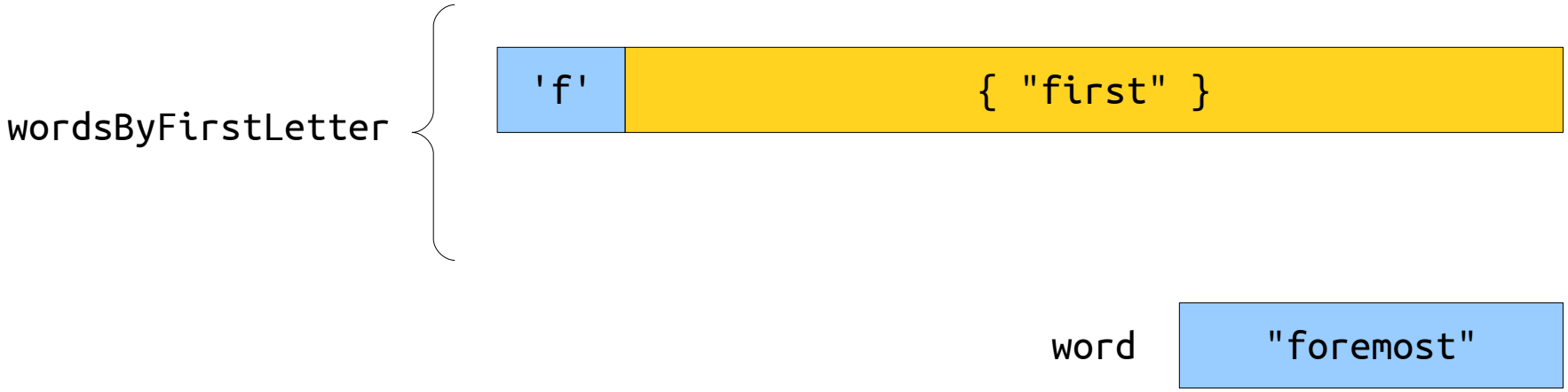

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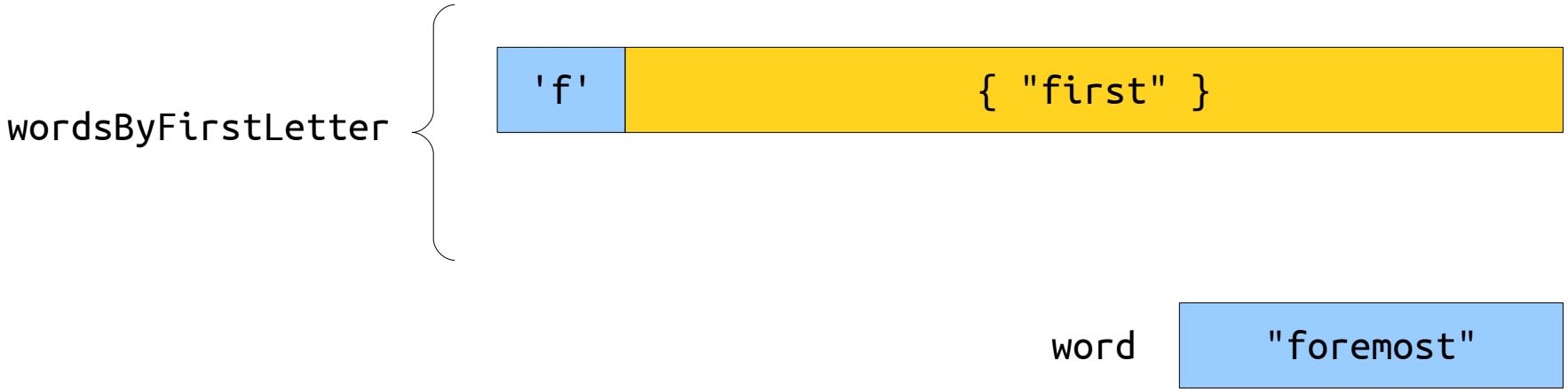

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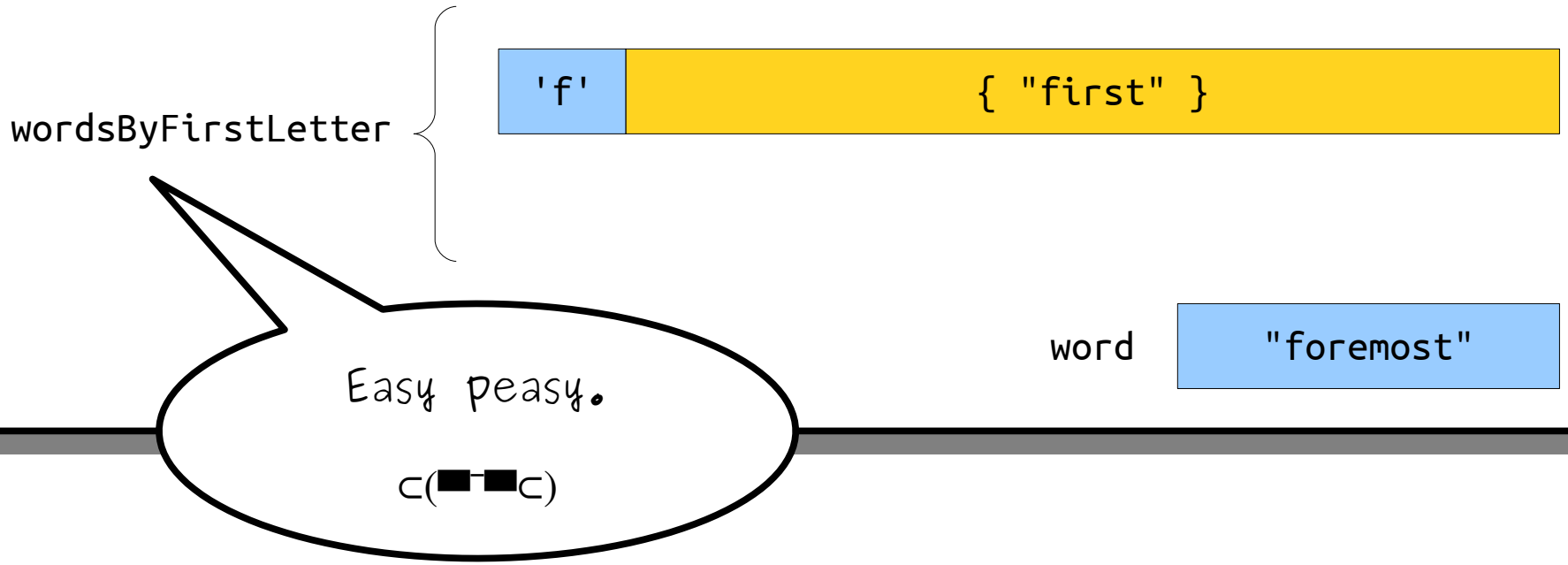

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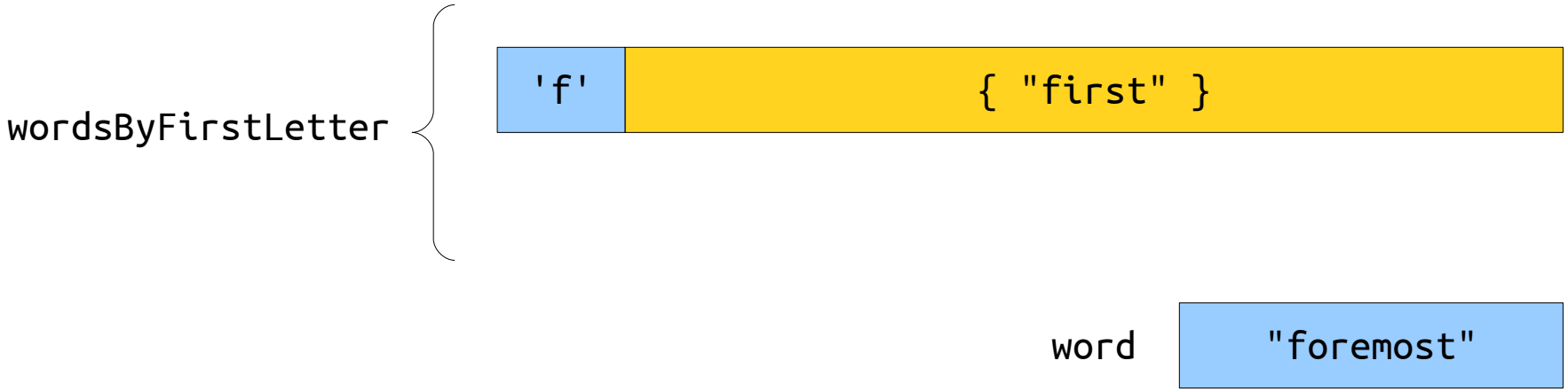

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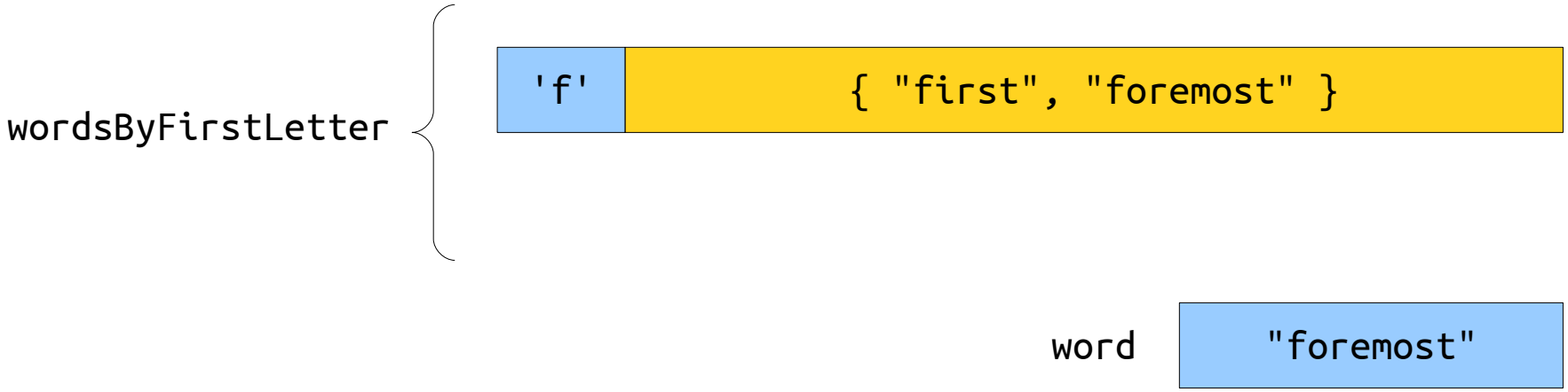

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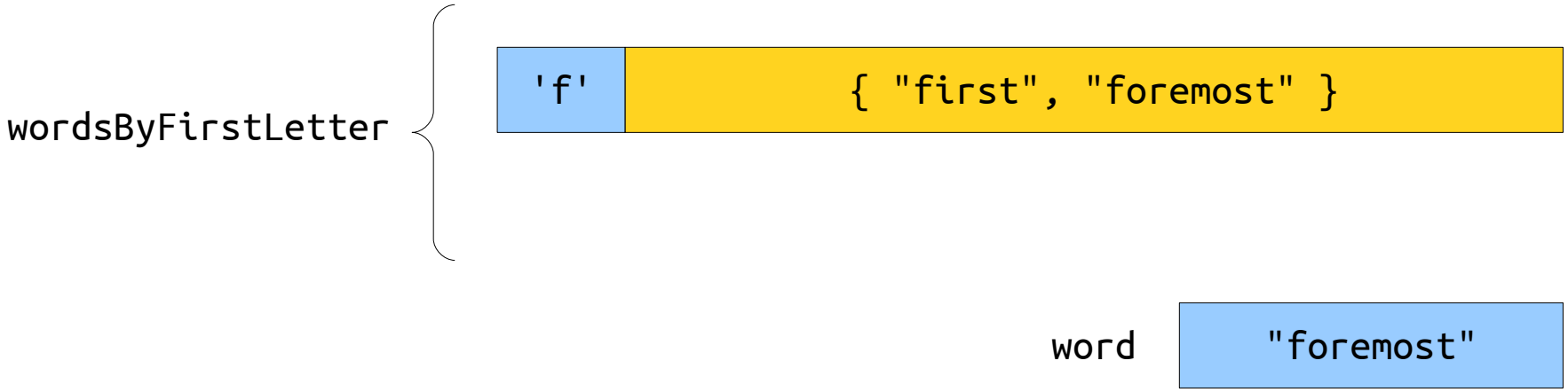

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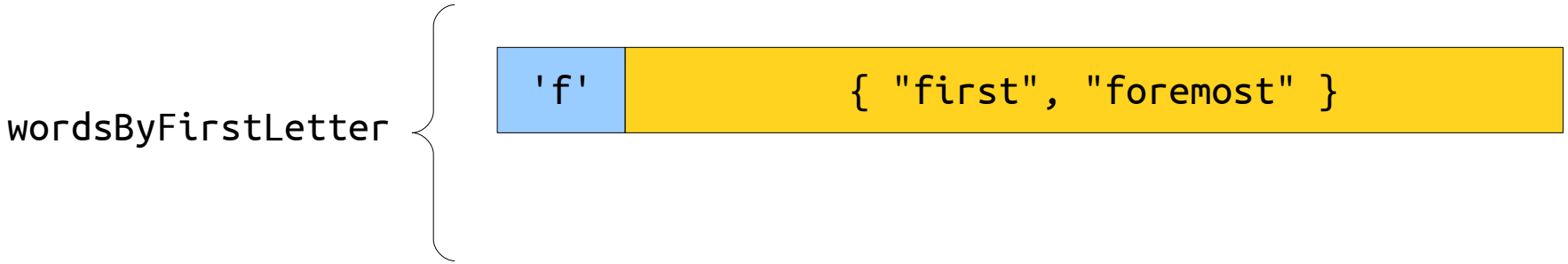

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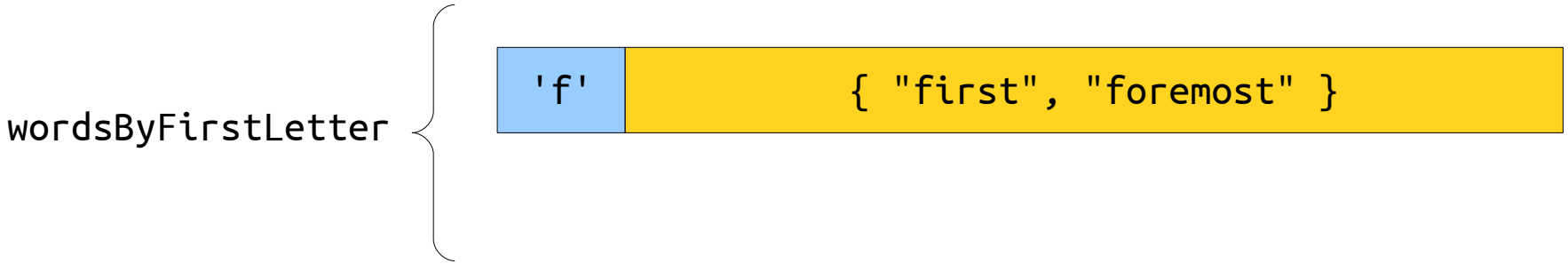

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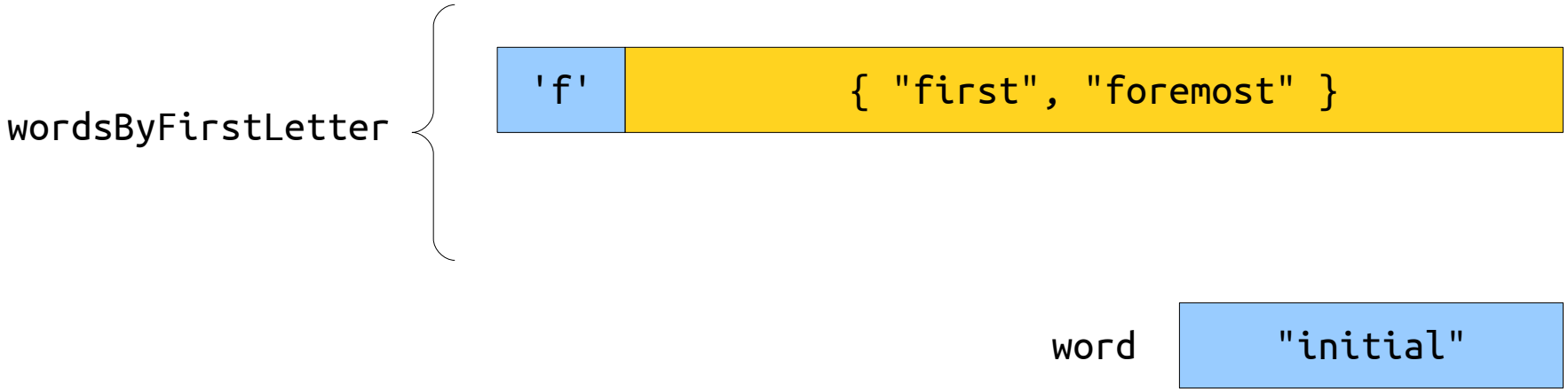

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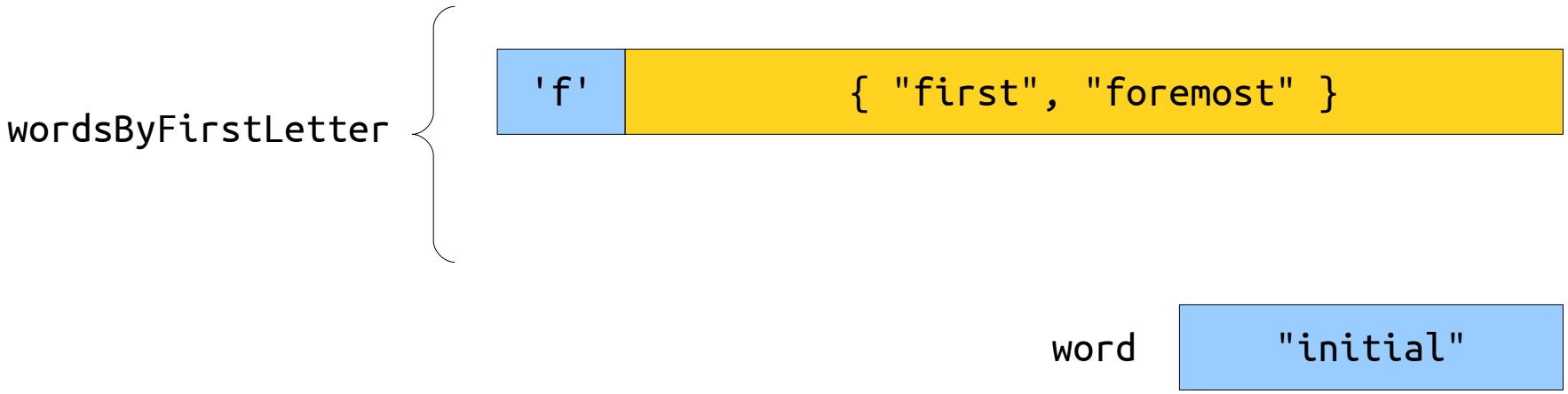

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```

wordsByFirstLetter

'f'	{ "first", "foremost" }
'i'	{ }

word "initial"

Map Autoinsertion

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}
```

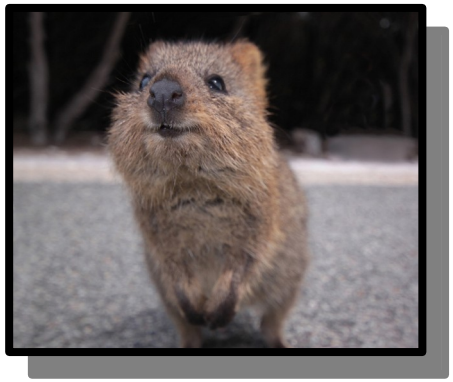
wordsByFirstLetter

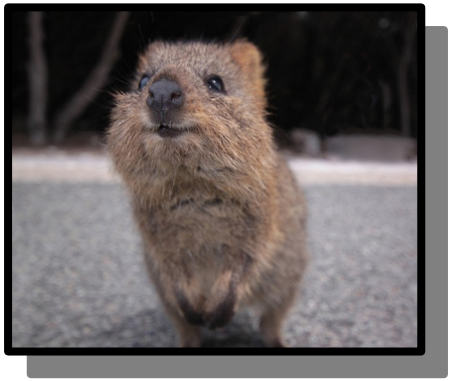
'f'	{ "first", "foremost" }
'i'	{ "initial" }

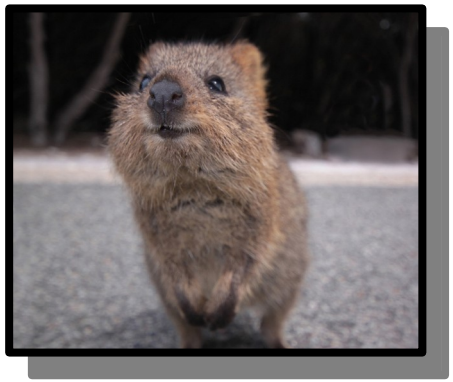
word "initial"

Quokka

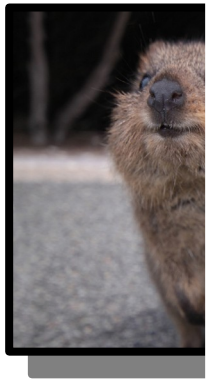
Quokka Quincunx

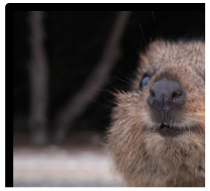






Quarter Quokka Quincunx





Anagrams

Anagrams

- Two words are ***anagrams*** of one another if the letters in one can be rearranged into the other.
- Some examples:
  - “Praising” and “aspiring.”
  - “Arrogant” and “tarragon.”
- ***Question for you:*** does this concept exist in other languages? If so, please send me examples!

Anagrams

- ***Nifty fact:*** two words are anagrams if you get the same string when you write the letters in those words in sorted order.
- For example, “praising” and “aspiring” are anagrams because, in both cases, you get the string “aiignprs” if you sort the letters.

Anagram Clusters

- Let's group all words in English into "clusters" of words that are all anagrams of one another.
- We'll use a `Map<string, Lexicon>`.
  - Each key is a string of letters in sorted order.
  - Each value is the collection of English words that have those letters in that order.

Your Action Items

- ***Read Chapter 5.***
  - It’s all about container types, and it’ll fill in any remaining gaps from this week.
- ***Start Assignment 2.***
  - Make slow and steady progress here, if you can. Aim to complete Rising Tides and to have started You Got Hufflepuff!

Next Time

- ***Thinking Recursively***
  - How can you best solve problems using recursion?
  - What techniques are necessary to do so?
  - And what problems yield easily to a recursive solution?

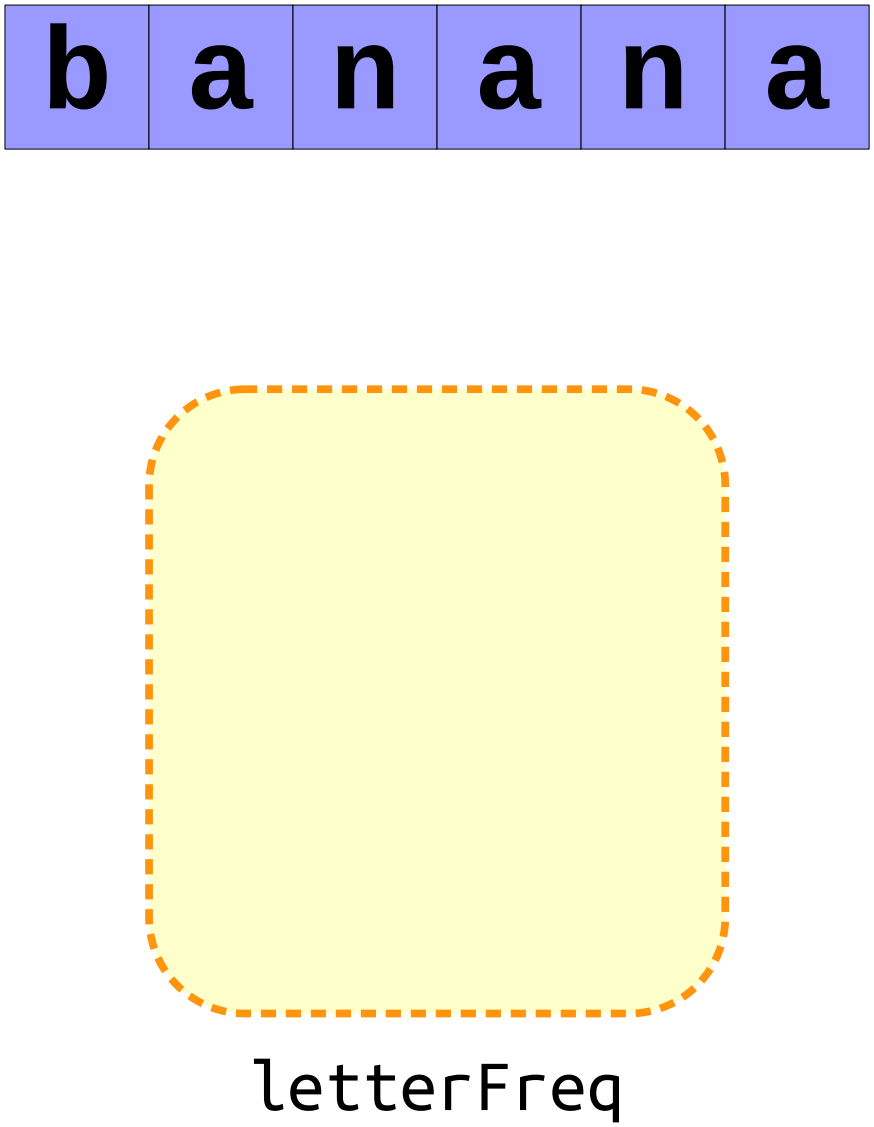
Appendix: How to Sort a String

Counting Sort

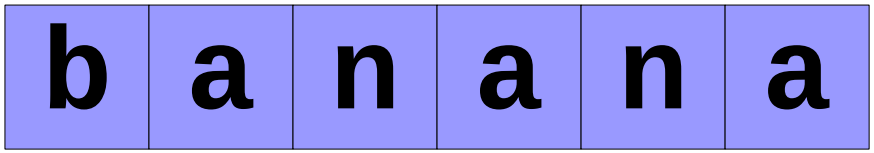
Counting Sort

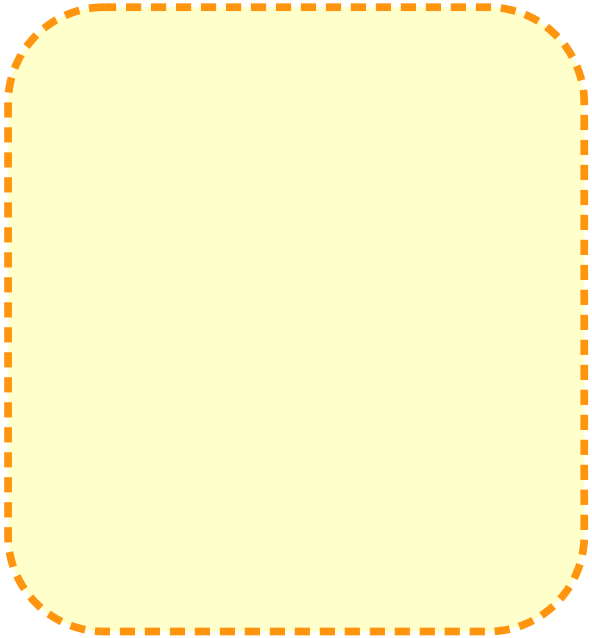
b	**a**	**n**	**a**	**n**	**a**

Counting Sort



Counting Sort

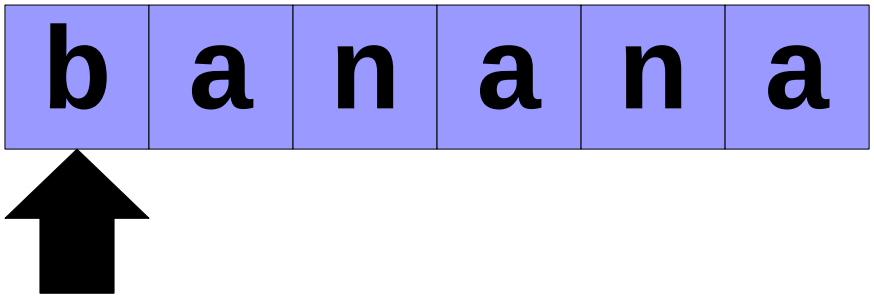


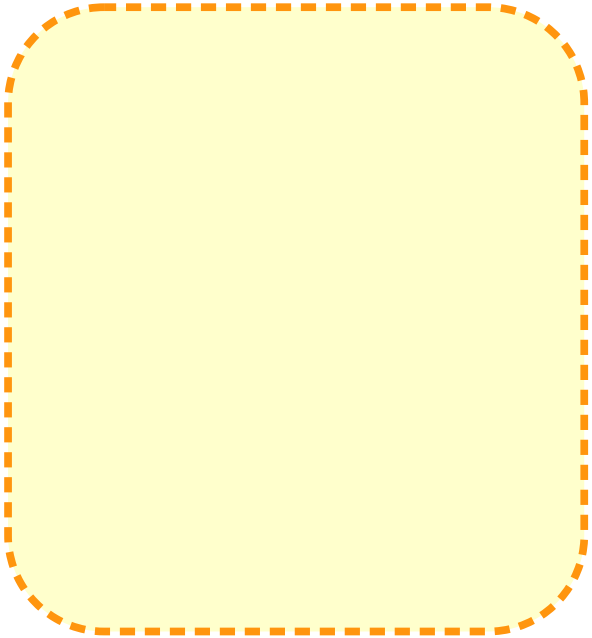


letterFreq

```
for (char ch: input) {
    letterFreq[ch]++;
}
```

Counting Sort





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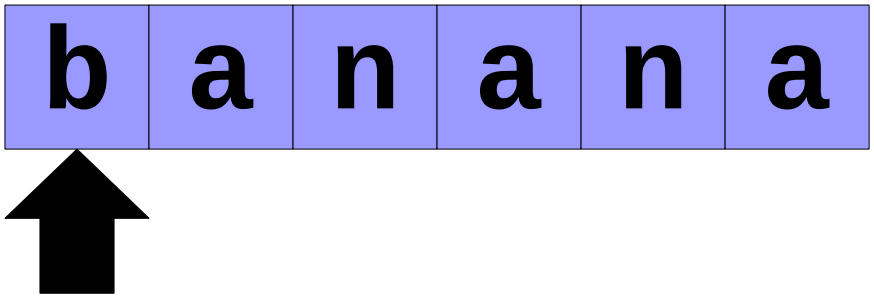

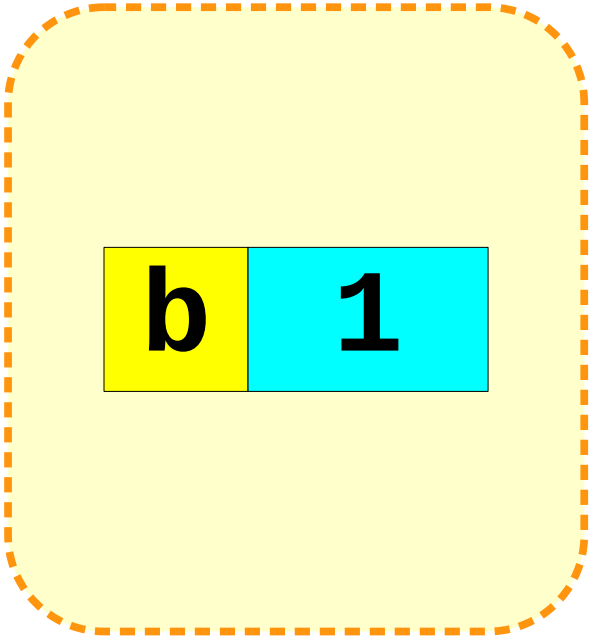

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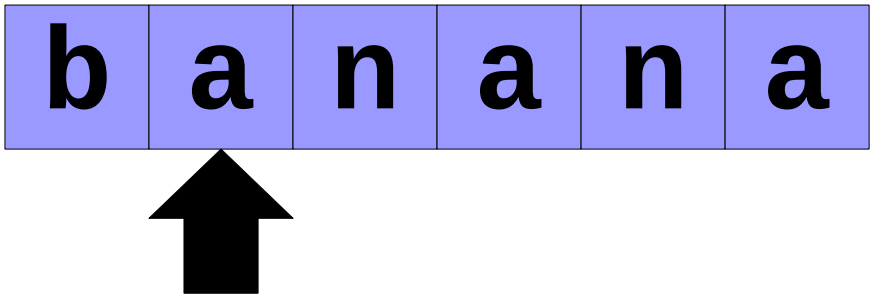
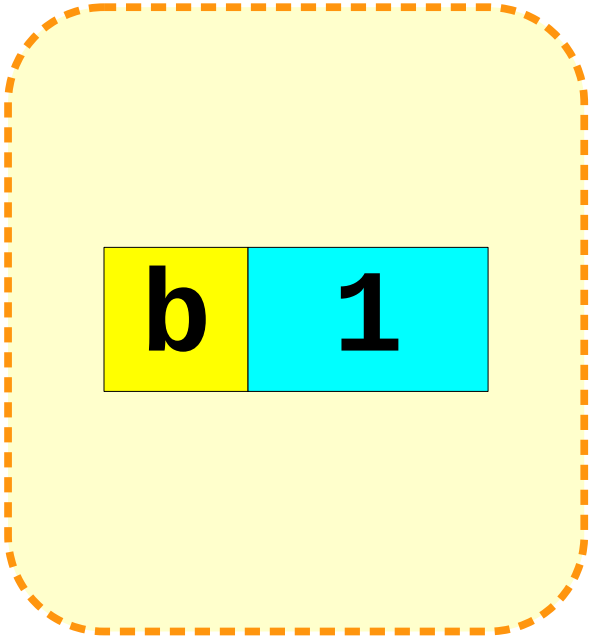
```

Counting Sort

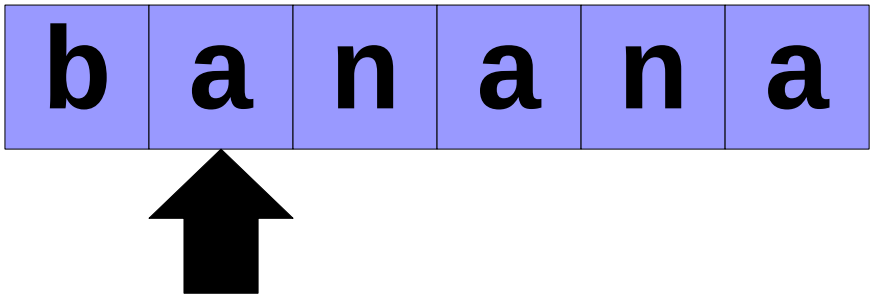


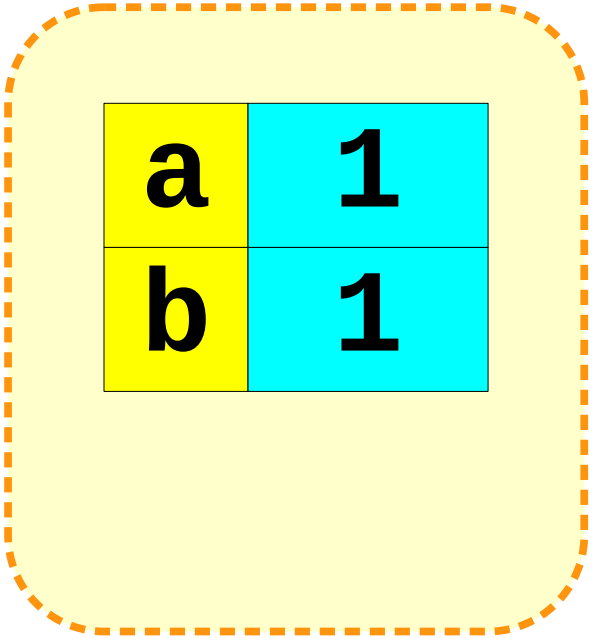


letterFreq

```
for (char ch: input) {
    letterFreq[ch]++;
}
```

Counting Sort

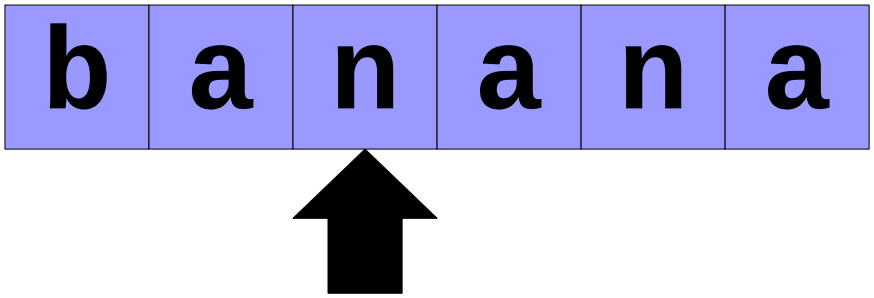


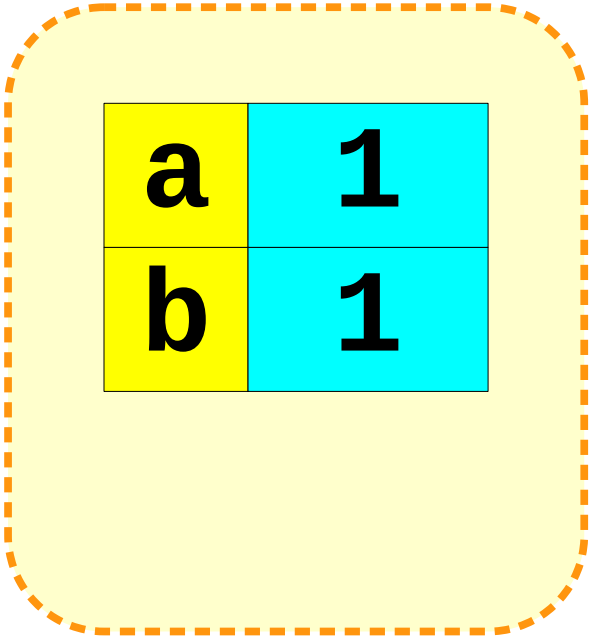


letterFreq

```
for (char ch: input) {
    letterFreq[ch]++;
}
```

Counting Sort

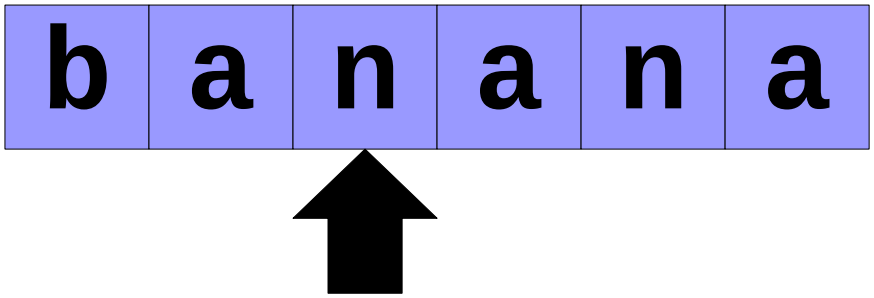


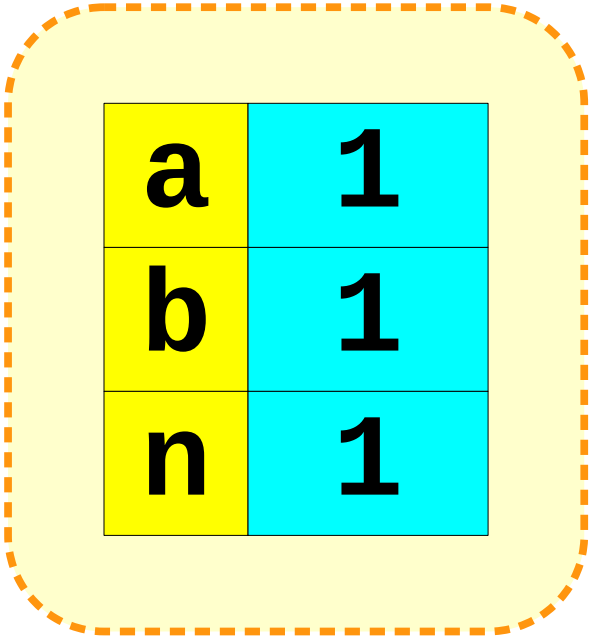


letterFreq

```
for (char ch: input) {
    letterFreq[ch]++;
}
```

Counting Sort

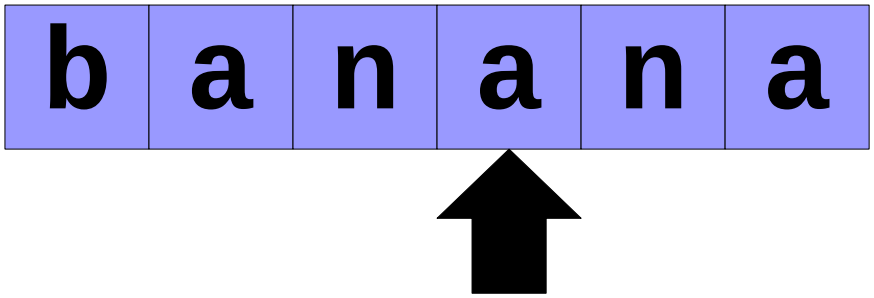


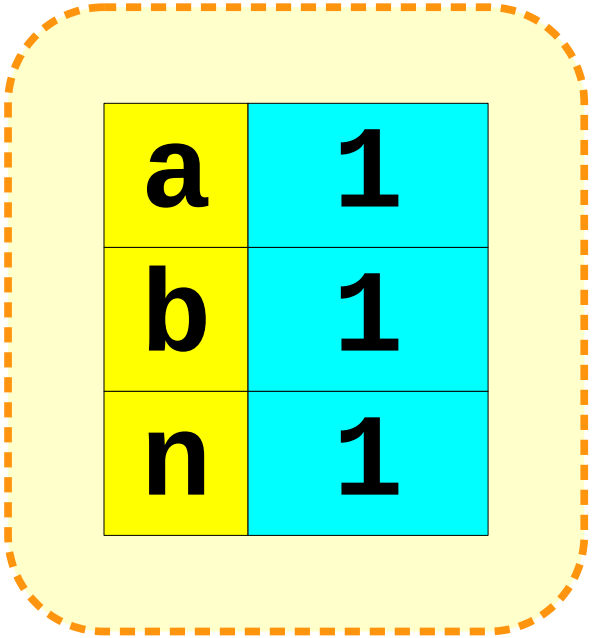


letterFreq

```
for (char ch: input) {
    letterFreq[ch]++;
}
```

Counting Sort

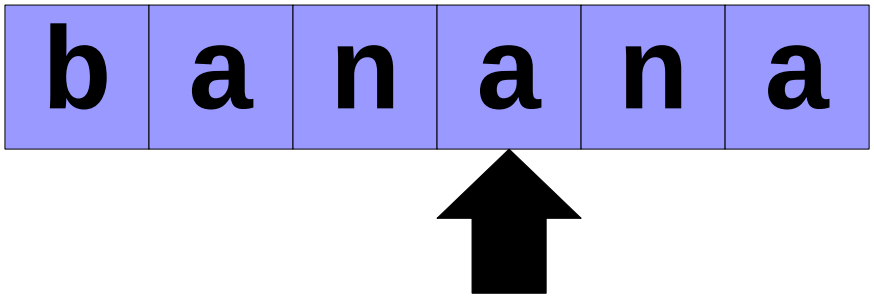


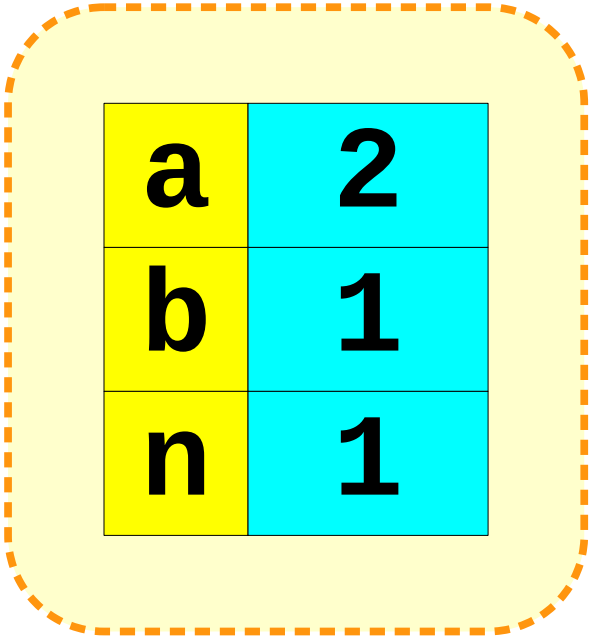


letterFreq

```
for (char ch: input) {
    letterFreq[ch]++;
}
```

Counting Sort

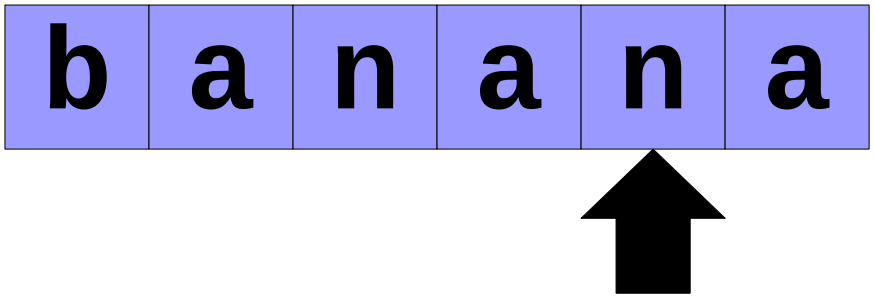


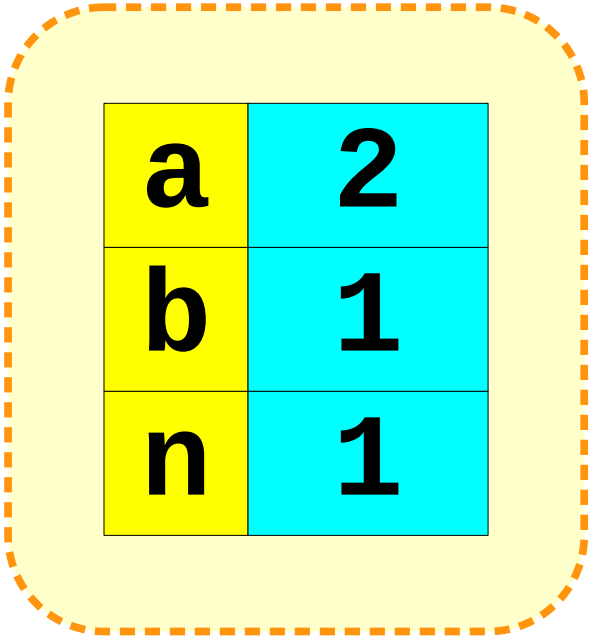


letterFreq

```
for (char ch: input) {
    letterFreq[ch]++;
}
```

Counting Sort

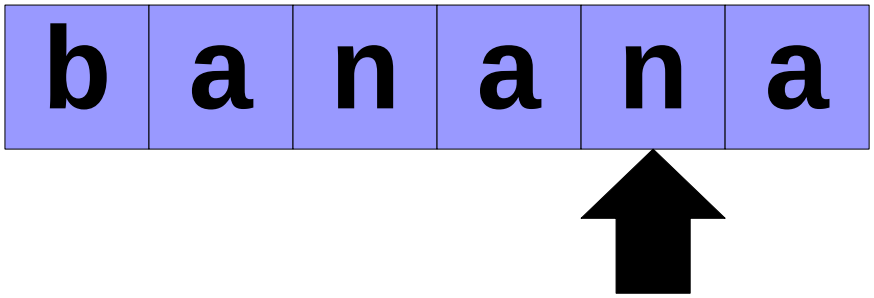


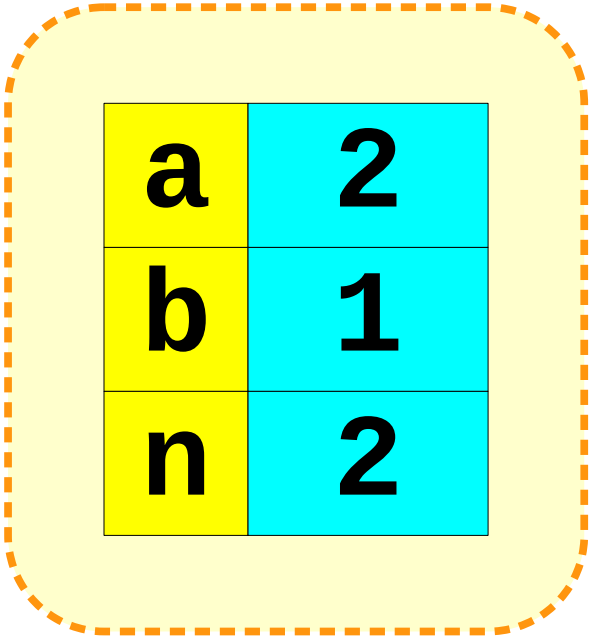


letterFreq

```
for (char ch: input) {
    letterFreq[ch]++;
}
```

Counting Sort

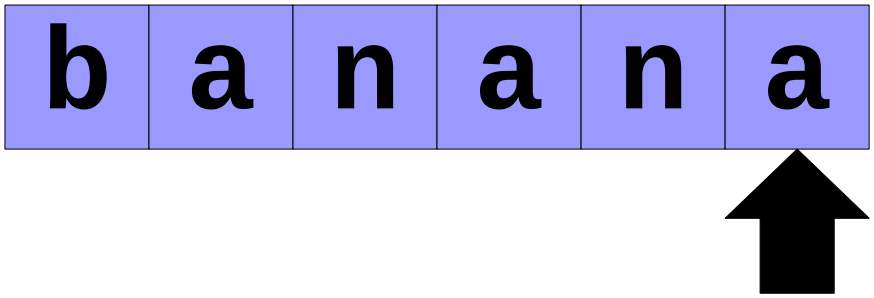


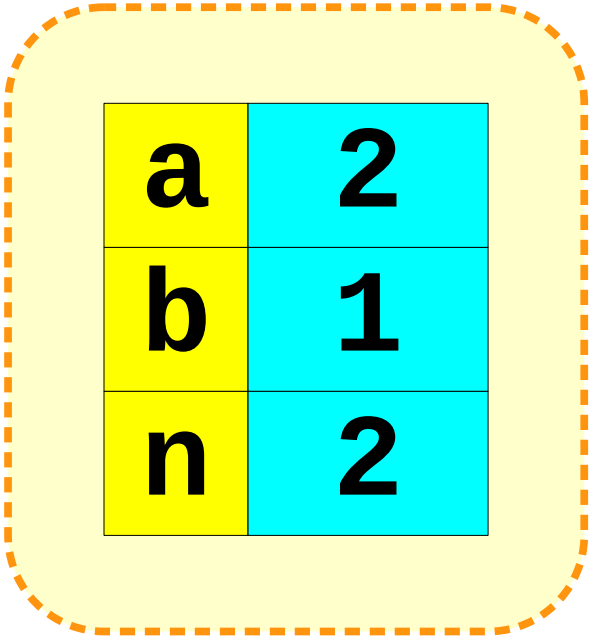


letterFreq

```
for (char ch: input) {
    letterFreq[ch]++;
}
```

Counting Sort

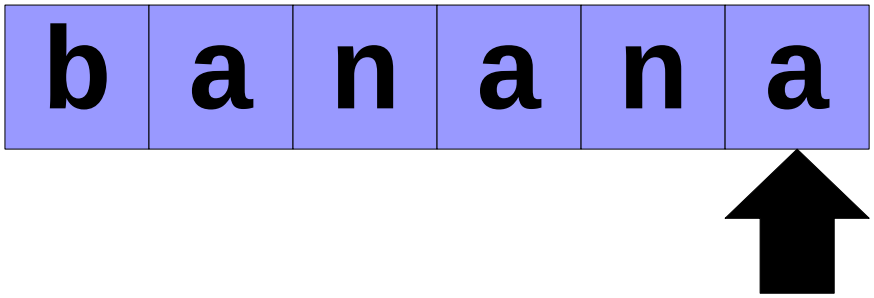


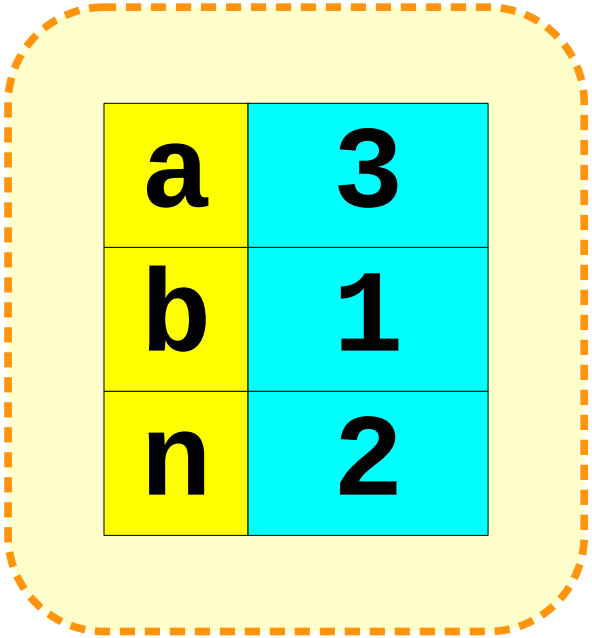


letterFreq

```
for (char ch: input) {
    letterFreq[ch]++;
}
```

Counting Sort





letterFreq

```
for (char ch: input) {
    letterFreq[ch]++;
}
```

Counting Sort

b	a	n	a	n	a

a	3
b	1
n	2

`letterFreq`

Counting Sort

b	a	n	a	n	a

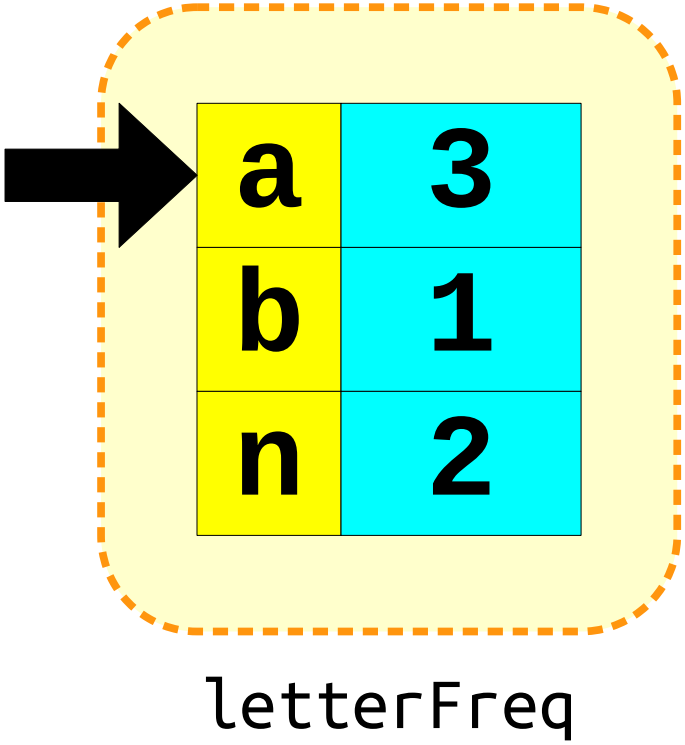
a	3
b	1
n	2

letterFreq

```
for (char ch = 'a'; ch <= 'z'; ch++) {
    for (int i = 0; i < letterFreq[ch]; i++) {
        result += ch;
    }
}
```

Counting Sort

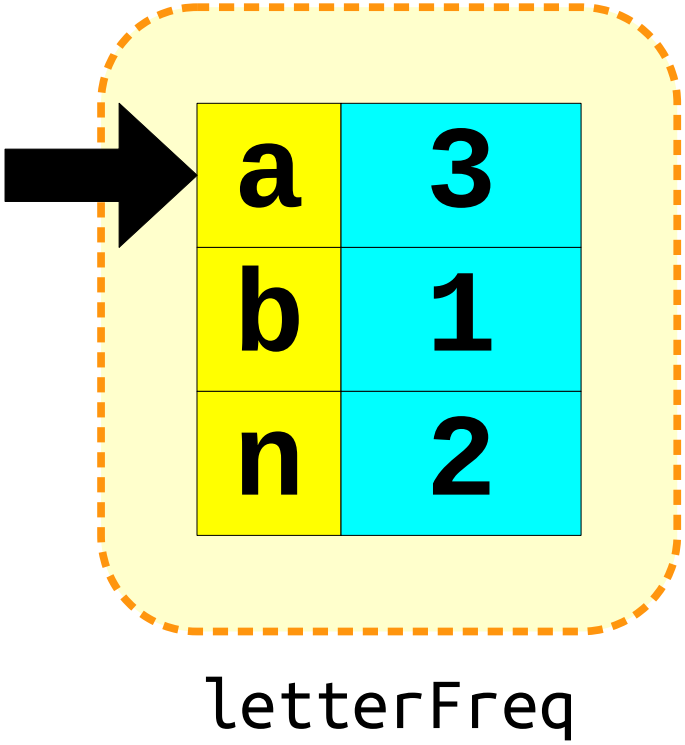
b	a	n	a	n	a




```
for (char ch = 'a'; ch <= 'z'; ch++) {
    for (int i = 0; i < letterFreq[ch]; i++) {
        result += ch;
    }
}
```

Counting Sort

b	a	n	a	n	a

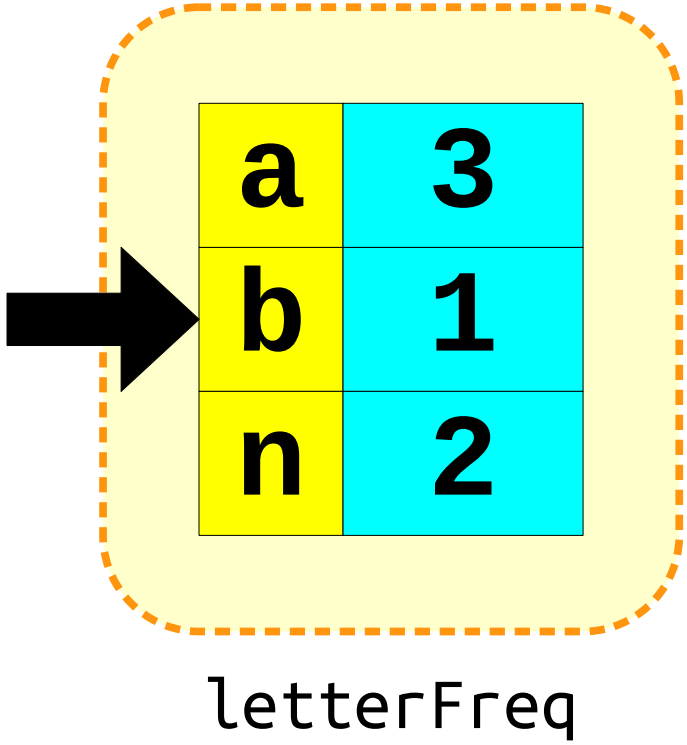



```
for (char ch = 'a'; ch <= 'z'; ch++) {
    for (int i = 0; i < letterFreq[ch]; i++) {
        result += ch;
    }
}
```

a	a	a

Counting Sort

b	a	n	a	n	a

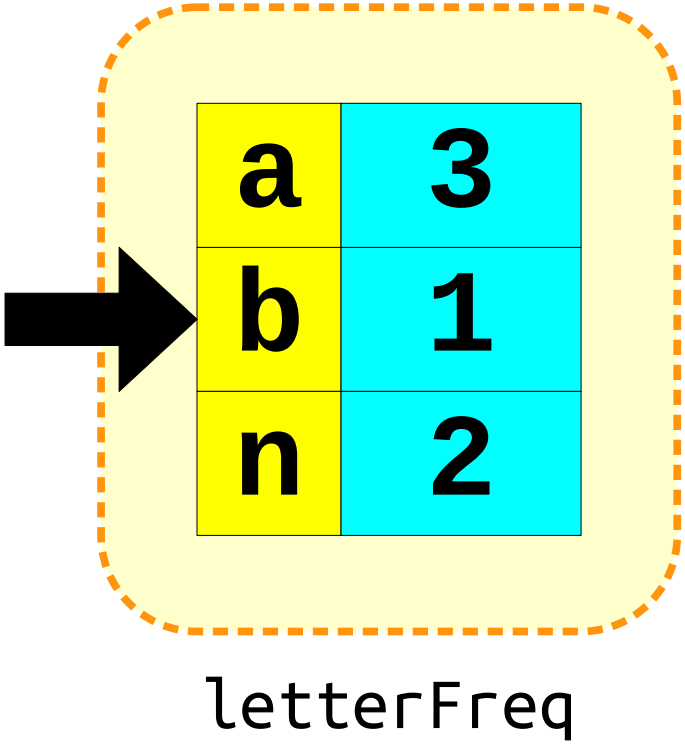



```
for (char ch = 'a'; ch <= 'z'; ch++) {
    for (int i = 0; i < letterFreq[ch]; i++) {
        result += ch;
    }
}
```

a	a	a

Counting Sort

b	a	n	a	n	a

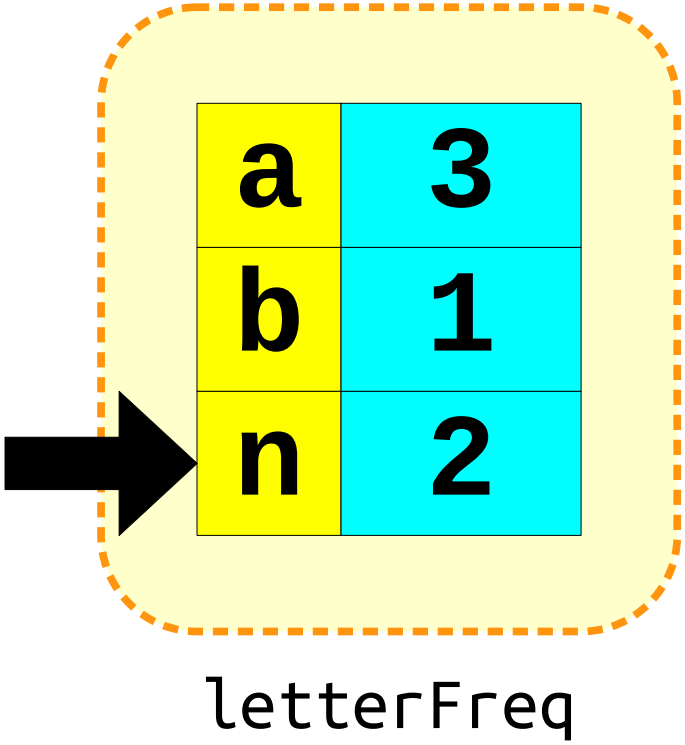



```
for (char ch = 'a'; ch <= 'z'; ch++) {
    for (int i = 0; i < letterFreq[ch]; i++) {
        result += ch;
    }
}
```

a	a	a	b

Counting Sort

b	a	n	a	n	a

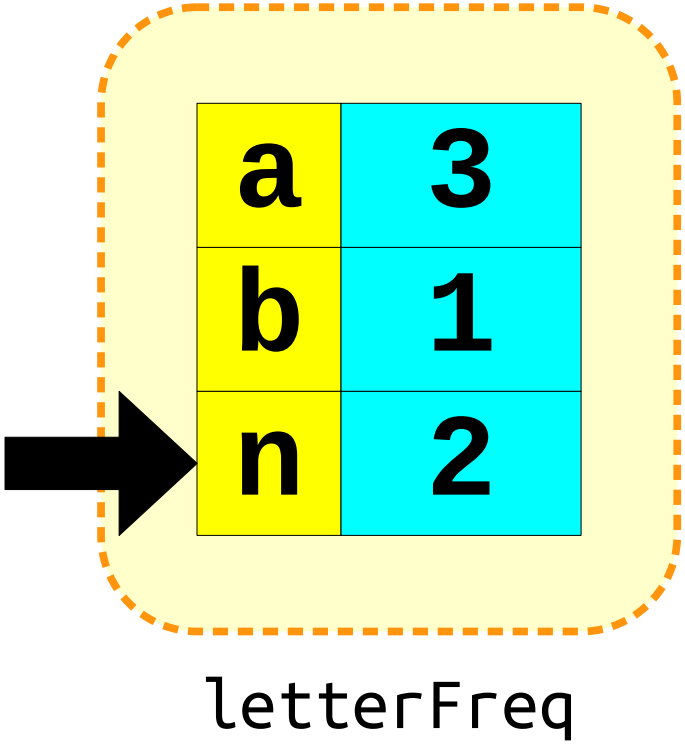



```
for (char ch = 'a'; ch <= 'z'; ch++) {
    for (int i = 0; i < letterFreq[ch]; i++) {
        result += ch;
    }
}
```

a	a	a	b

Counting Sort

b	a	n	a	n	a




```
for (char ch = 'a'; ch <= 'z'; ch++) {
    for (int i = 0; i < letterFreq[ch]; i++) {
        result += ch;
    }
}
```

a	a	a	b	n	n

Counting Sort

b	a	n	a	n	a

a	3
b	1
n	2

letterFreq

a	a	a	b	n	n