Collections

Announcements

- Casual CS Dinner for Women Studying Computer Science: **Thursday, March 7** at **6PM** in **Gates 219**!
- RSVP through the email link sent out earlier this week.

Announcements

- Assignment 6 (**NameSurfer**) out, due next **Wednesday, March 13** at 3:15PM.
- YEAH hours (assignment review hours) tonight from 7PM – 9PM in Hewlett T-175.
- Second Midterm exam next Monday, March 11 from 7PM – 10PM in MemAud.
  - Covers material up through and including today's lecture.
  - Solutions to first practice exam released now; another practice exam available (solutions out Friday).
  - Email Gil **no later than 11:59PM tonight** if you need to take the exam at an alternate time.
- Midterm review session this Saturday from 1PM – 3PM in Hewlett 200.

Organizing Data

- We have many ways of storing and organizing data in our programs:
  - **`String`**s for holding sequences of characters.
  - **`ArrayList`**s for holding sequences of general objects.
  - Arrays for holding fixed-sized sequences.
  - **`HashMap`**s for associating data with one another.
- Are there other ways of organizing data?
- What do they look like?

The Collections Framework

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The Collections Framework

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  - **`List`**s, which store sequences,
  - **`Map`**s, which store key/value pairs, and
  - **`Set`**s, which store unordered data.

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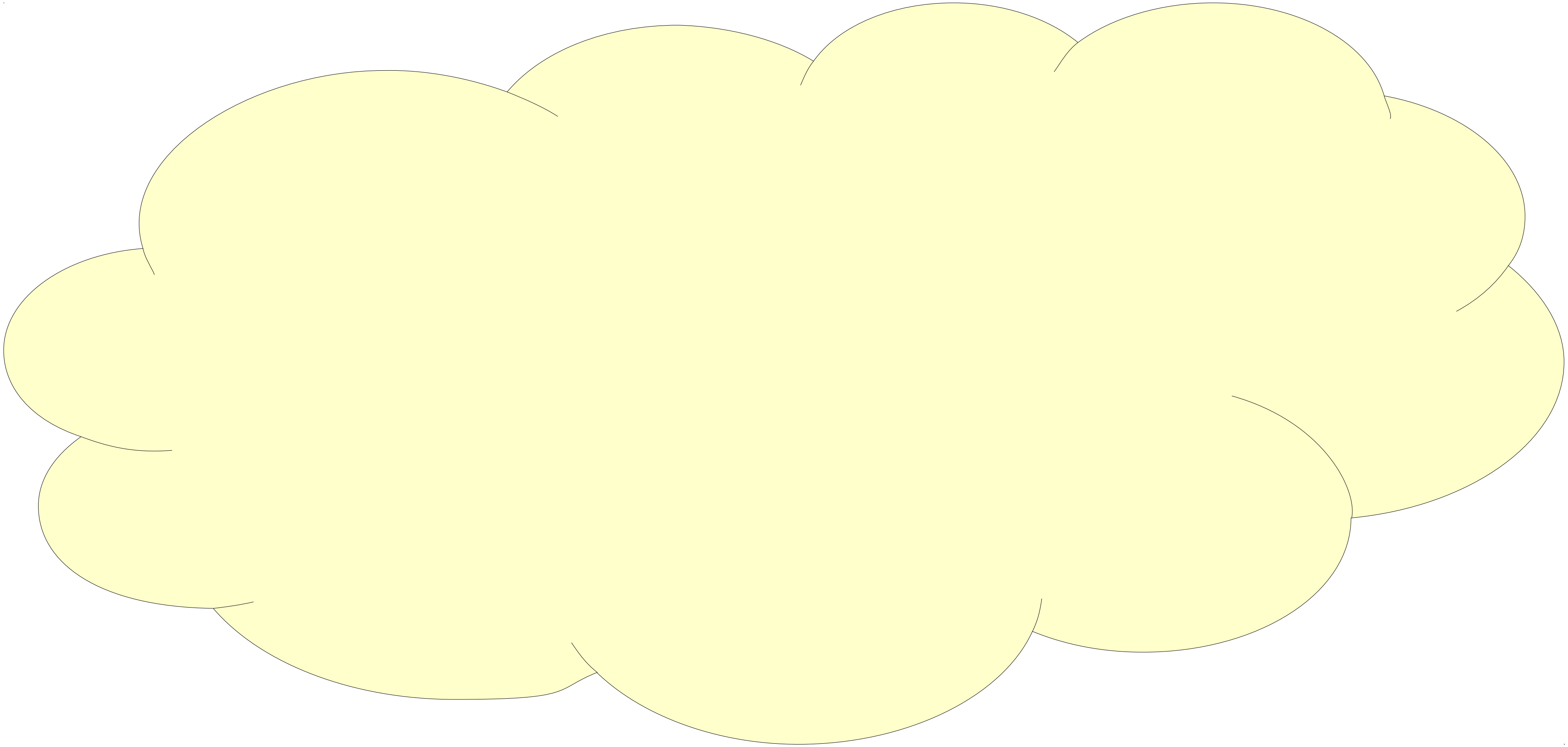
  - **`List`**s, which store sequences,
  - **`Map`**s, which store key/value pairs, and
  - **`Set`**s, which store unordered data.

What is a Set?

- A **set** is a collection of distinct elements.
- Similar to an **`ArrayList`**, but elements are not stored in a sequence.
- Major operations are:
  - Adding an element.
  - Removing an element.
  - Checking whether an element exists.
- Useful for answering questions of the form “have I seen this before?”



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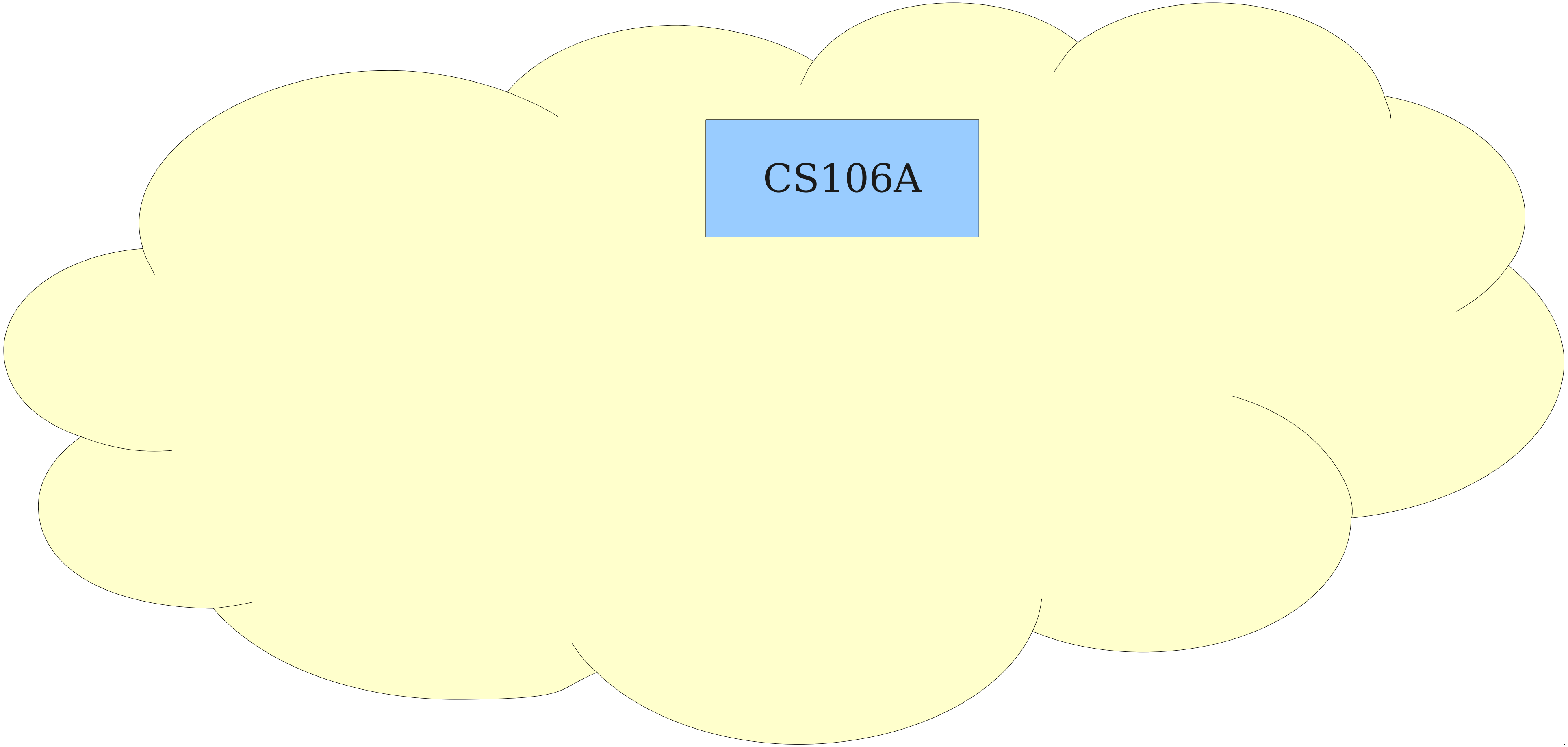
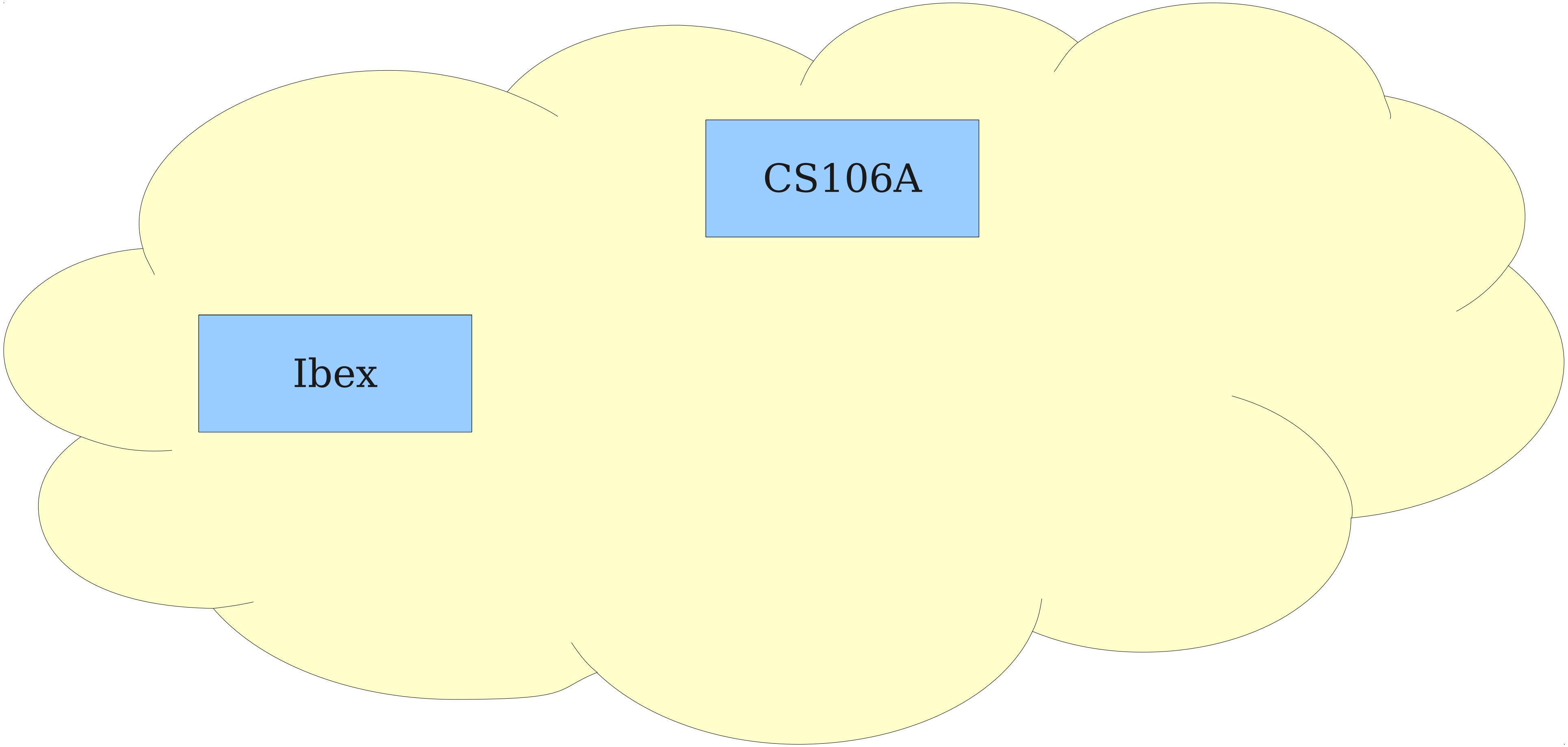


```
HashSet<String> mySet = new HashSet<String>();
mySet.add("CS106A");
```

To add a value to a **HashSet**, use the syntax

***set*.add(*value*)**



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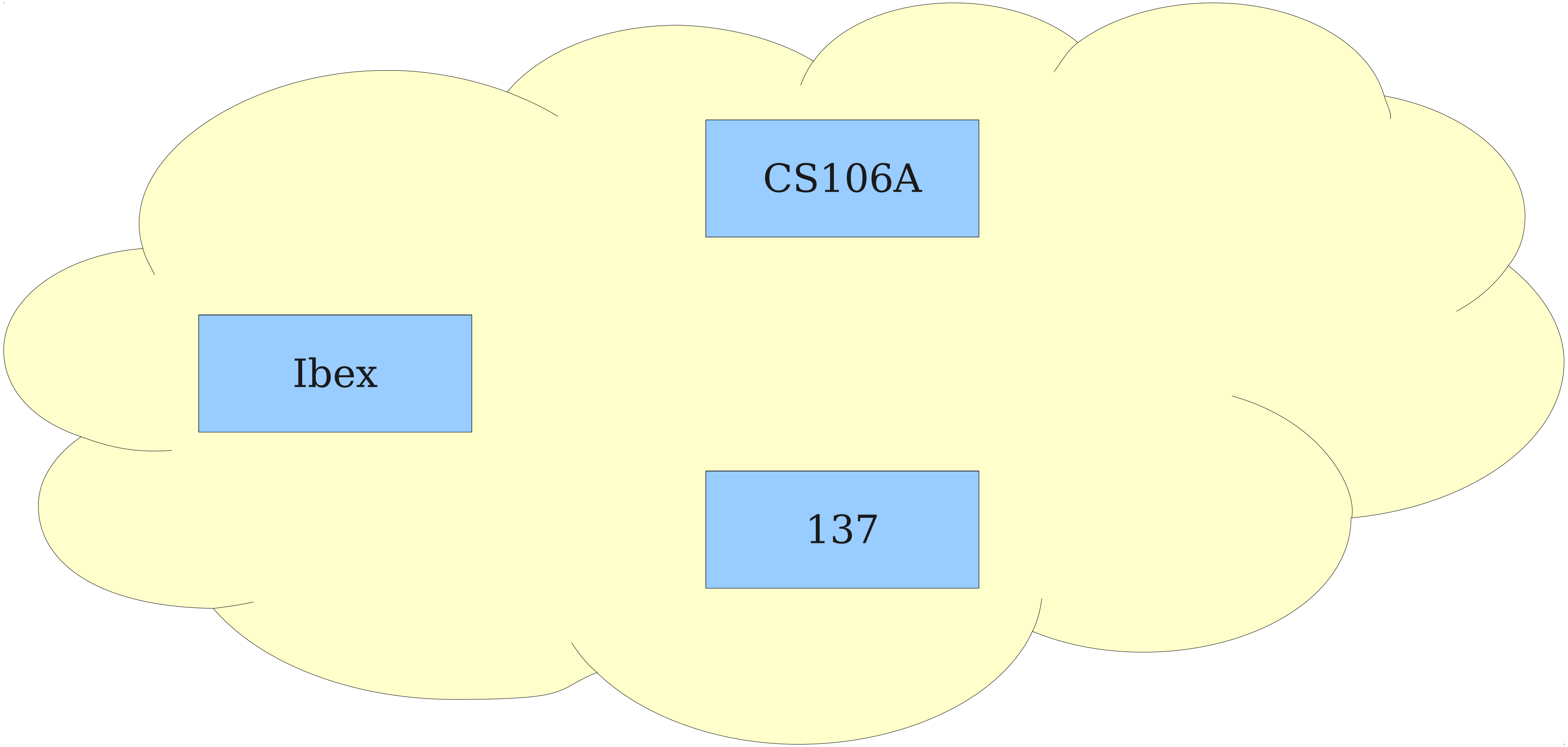
HashSet<String> mySet = new HashSet<String>();
mySet.add("CS106A");
mySet.add("Ibex");
```



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mySet.add("CS106A");
mySet.add("Ibex");
mySet.add("137");
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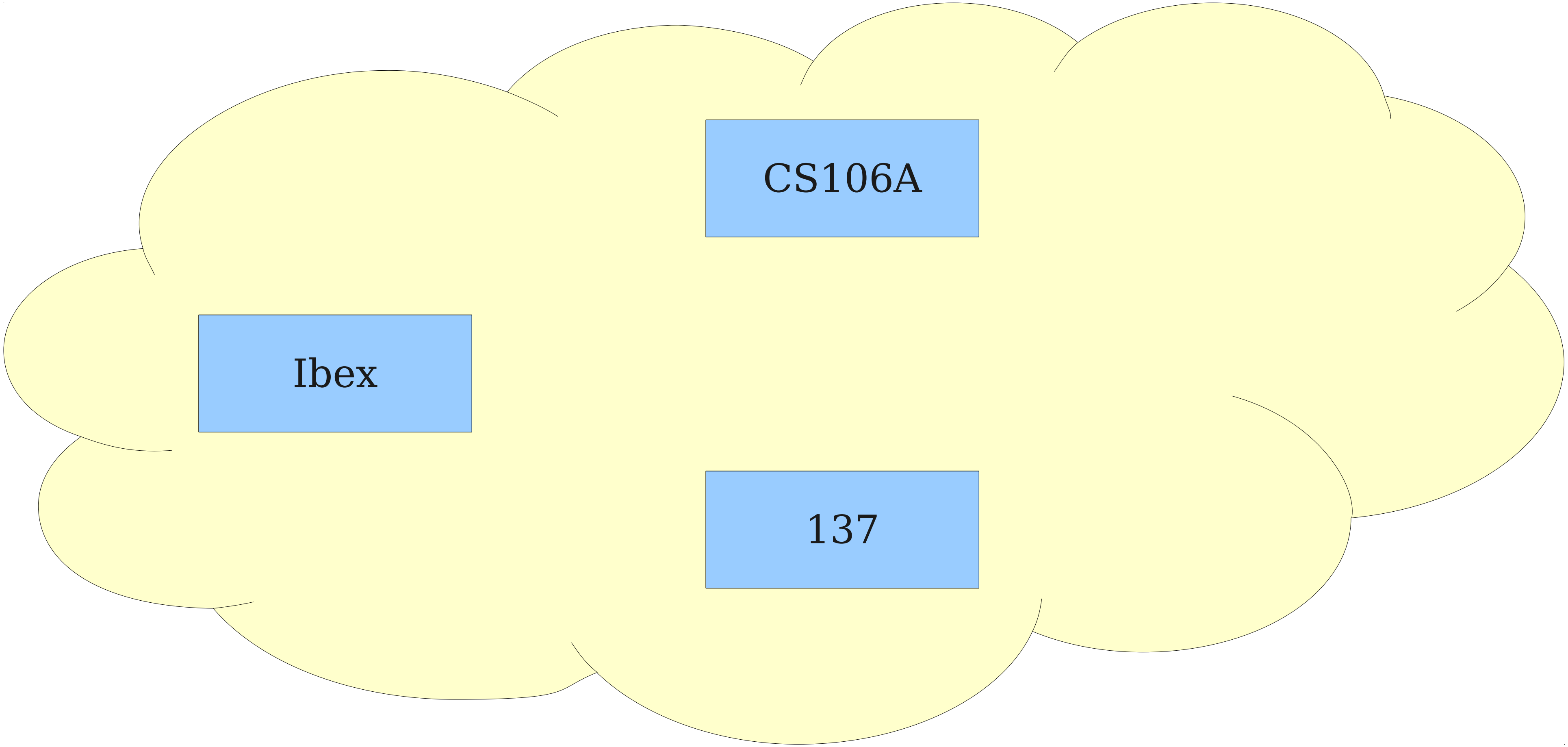

CS106A

Ibex

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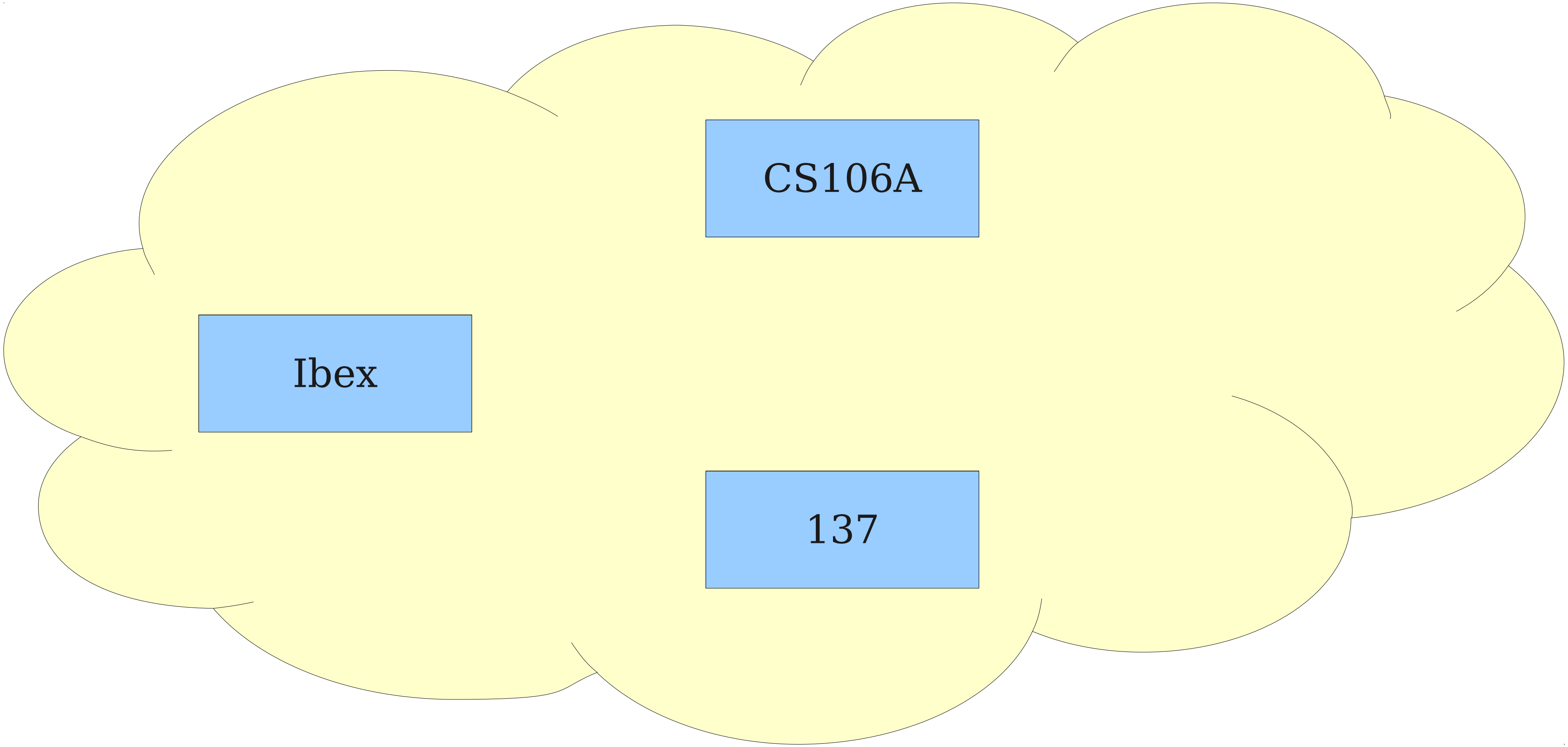
If you **add** a value where the value already exists, nothing happens.



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mySet.add("CS106A");
mySet.add("Ibex");
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mySet.add("CS106A");

mySet.contains("Ibex");
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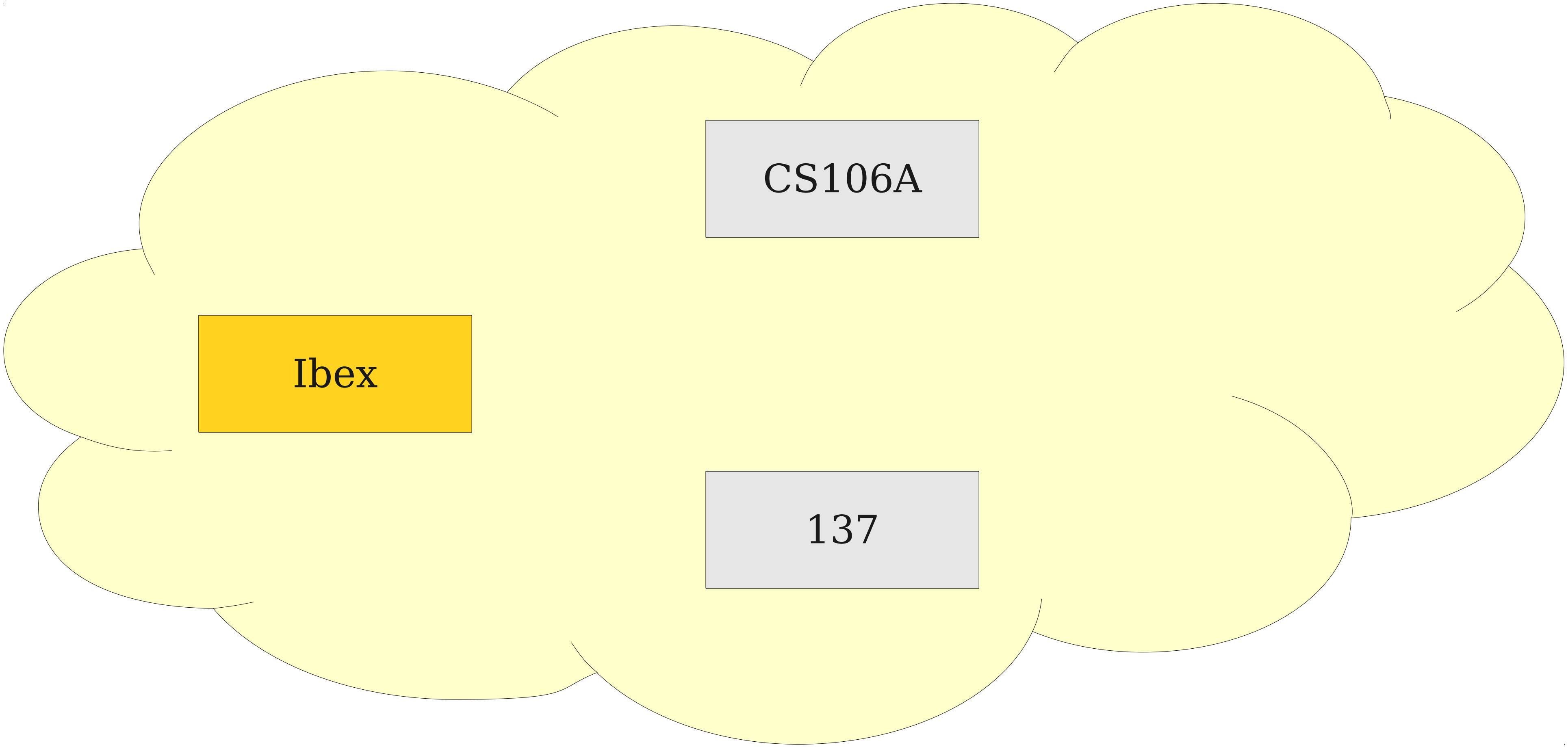

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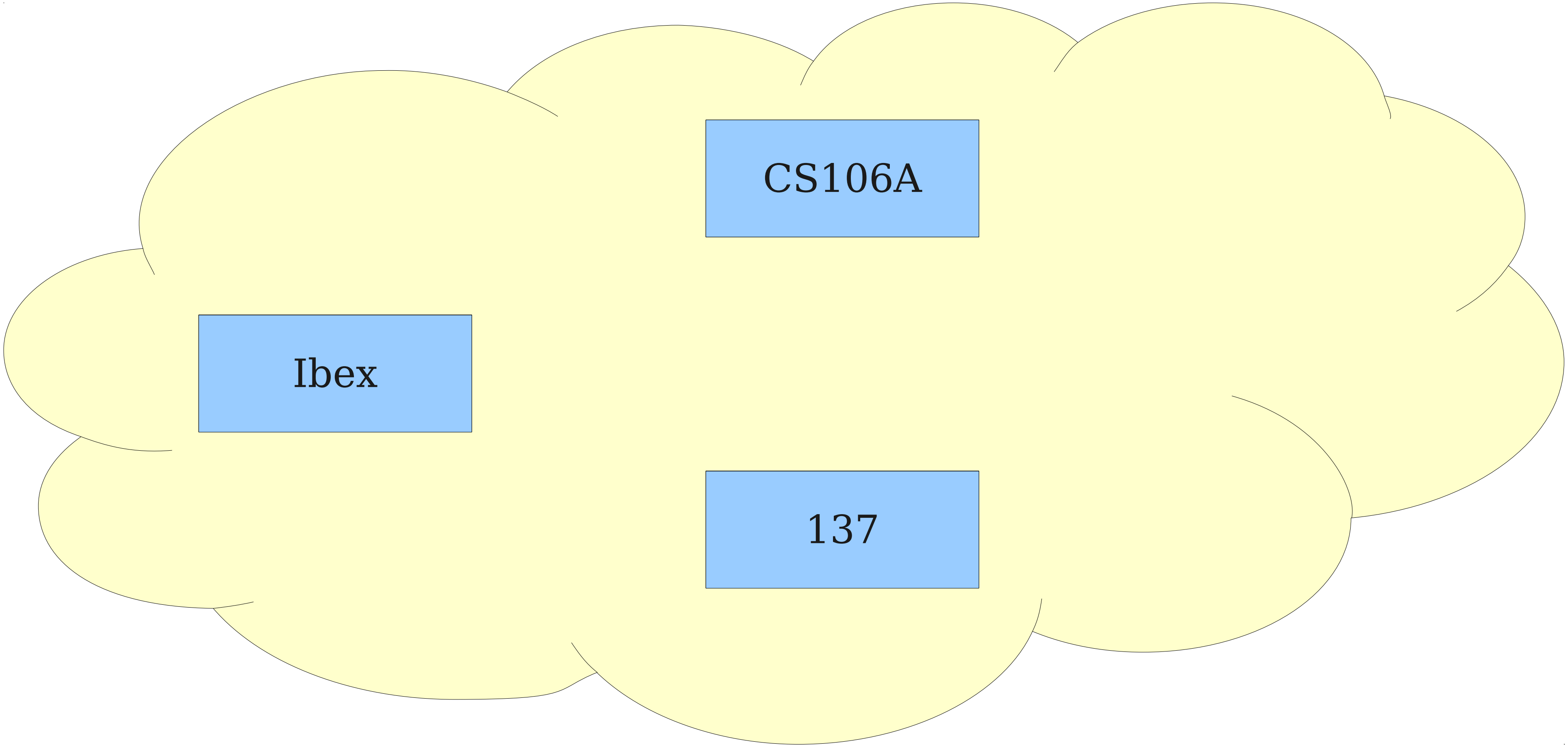
To see if a value exists:

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



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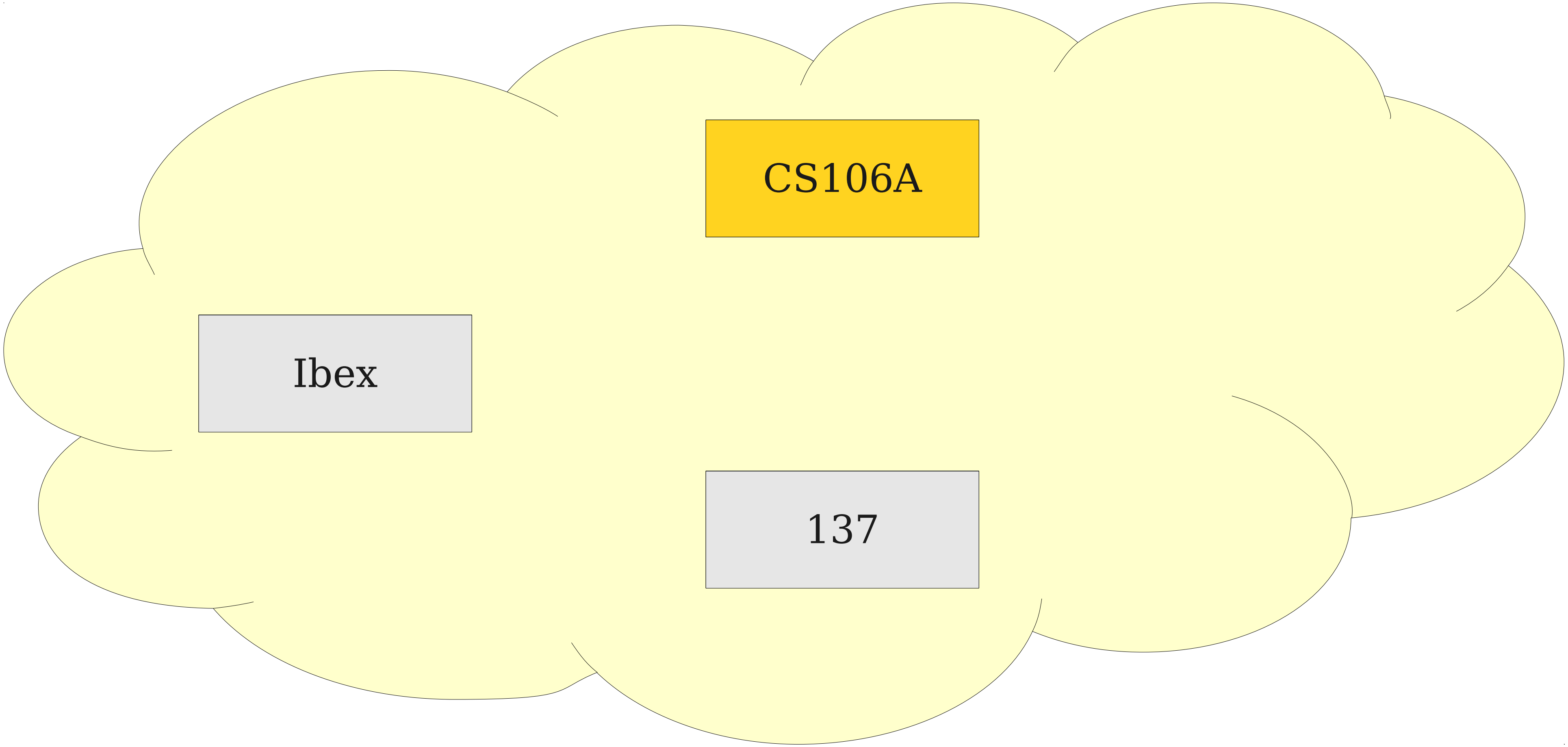

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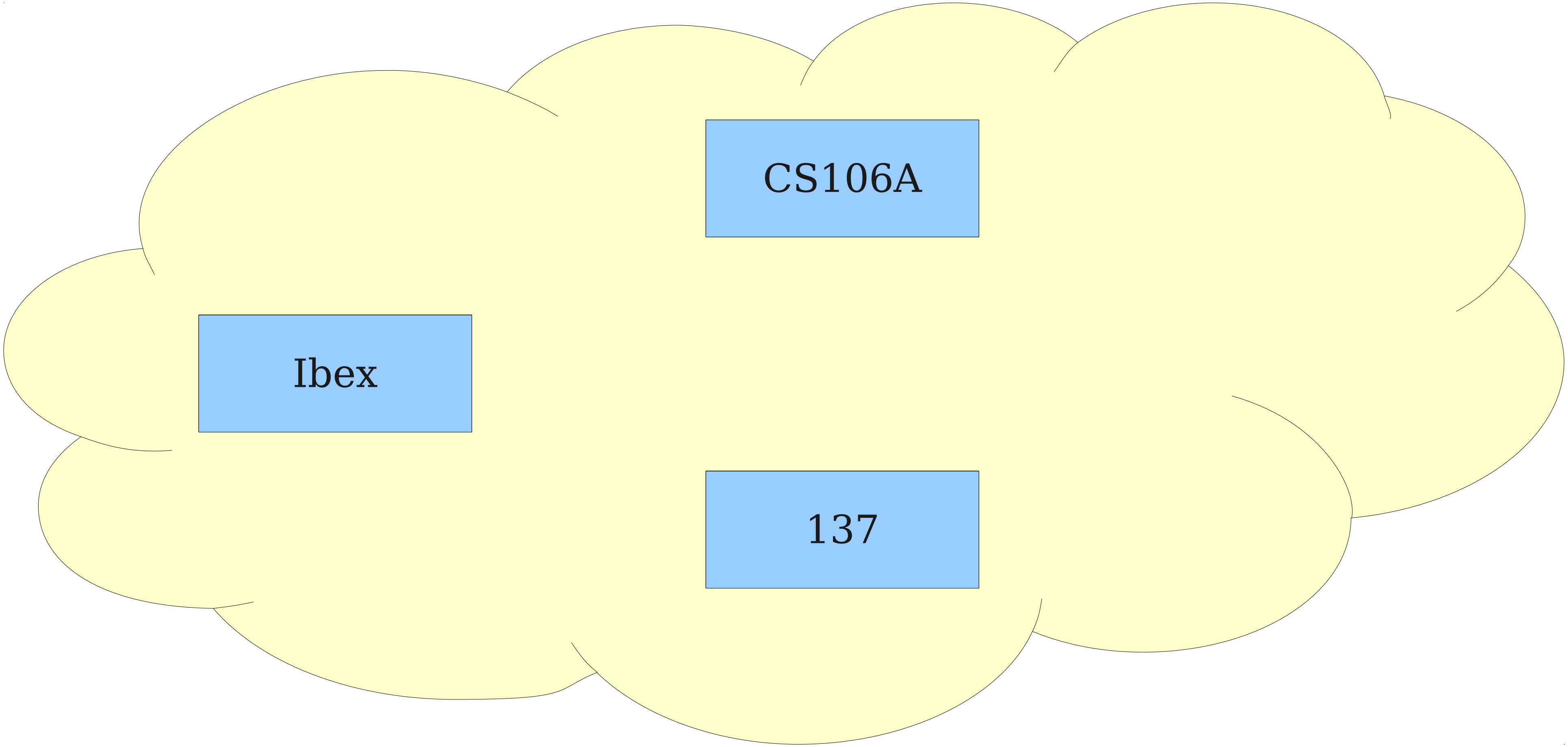

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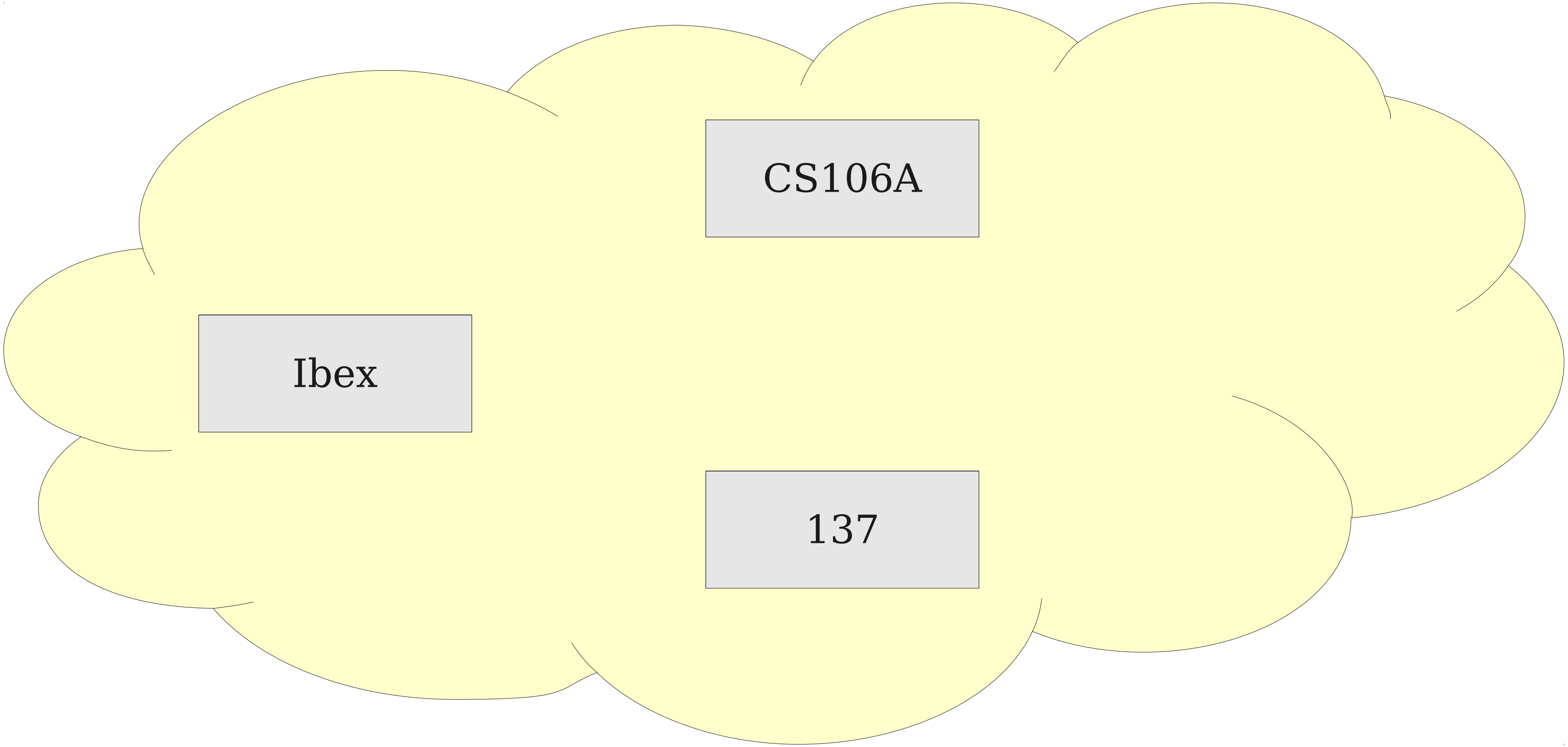

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Basic **`Set`** Operations

- To insert an element:

  ***set*`.add(`*value*`)`**

- To check whether a value exists:

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

- To remove an element:

  ***set*`.remove(`*value*`)`**

Free Association

The “for each” Loop

- You can iterate across all elements of a `HashSet` by using the “for each” loop:

```
for (Type value: set) {
   /* … do something with value … */
}
```

- This same loop can also be used on `ArrayList`, `String`, and arrays.

“For each” and Maps

- You can iterate across the keys of a **`HashMap`** by using the “for each” loop and the **`keySet`** method:

```
for (Type value: map.keySet()) {
   /* … do something with value … */
}
```

Iterators

- To visit every element of a collection, you can use the "for each" loop:

```
for (ElemType elem: collection) {
                    ...
}
```

- Alternatively, you can use an **iterator**, an object whose job is to walk over the elements of a collection.
- The iterator has two commands:
  - **`hasNext()`**, which returns whether there are any more elements to visit, and
  - **`next()`**, which returns the next element and moves the iterator to the next position.

Java Iterators

```
ArrayList<Integer> myList = /* … */

Iterator<Integer> iter = myList.iterator();
while (iter.hasNext()) {
    Integer curr = iter.next();

    /* … use curr … */
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Java Iterators

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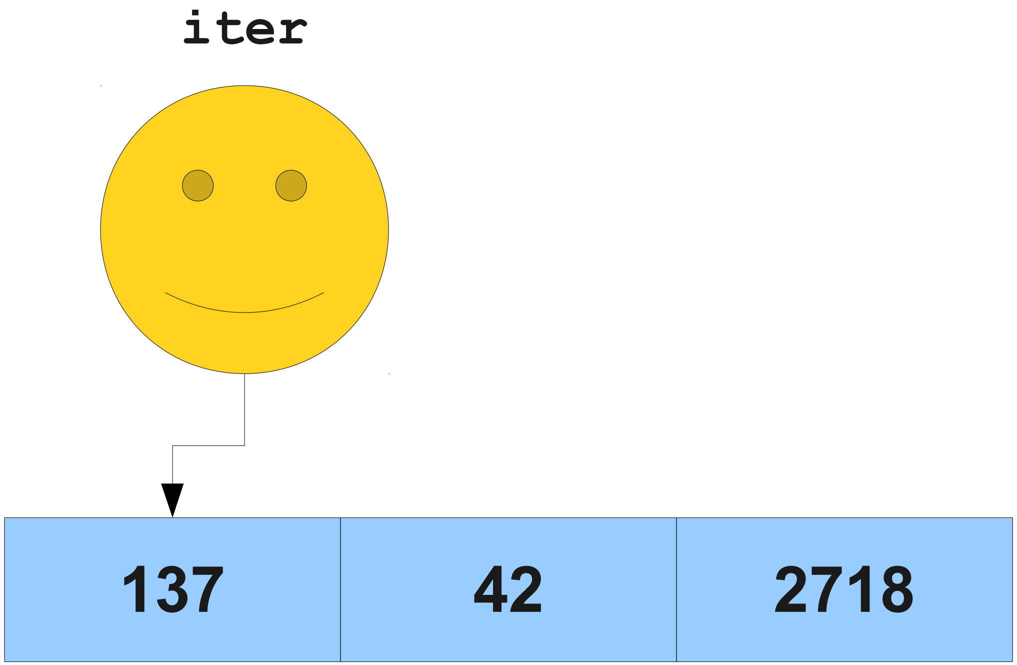

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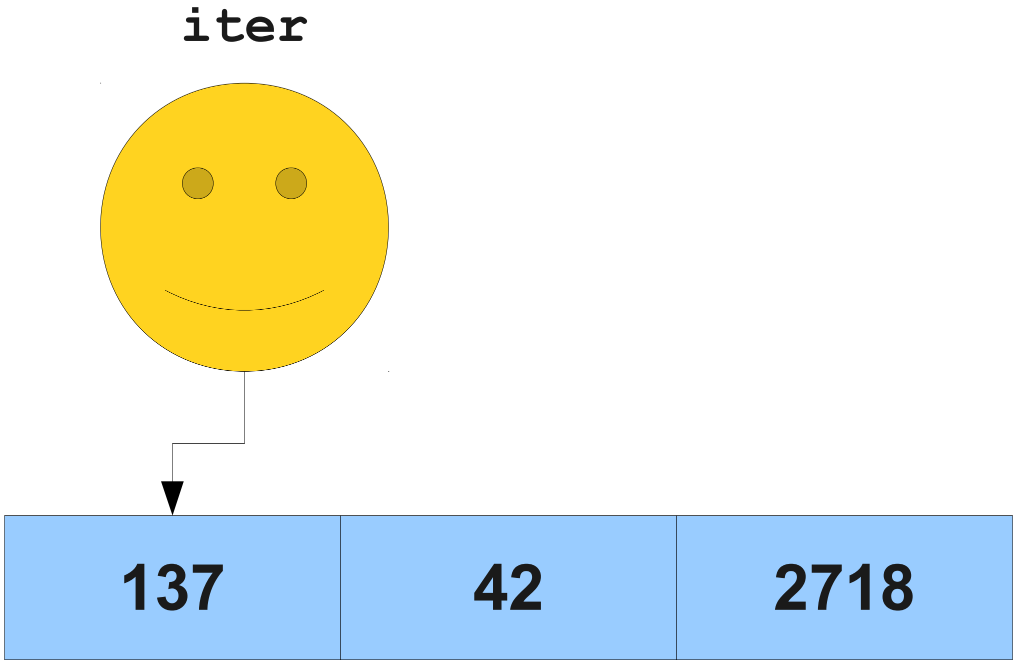

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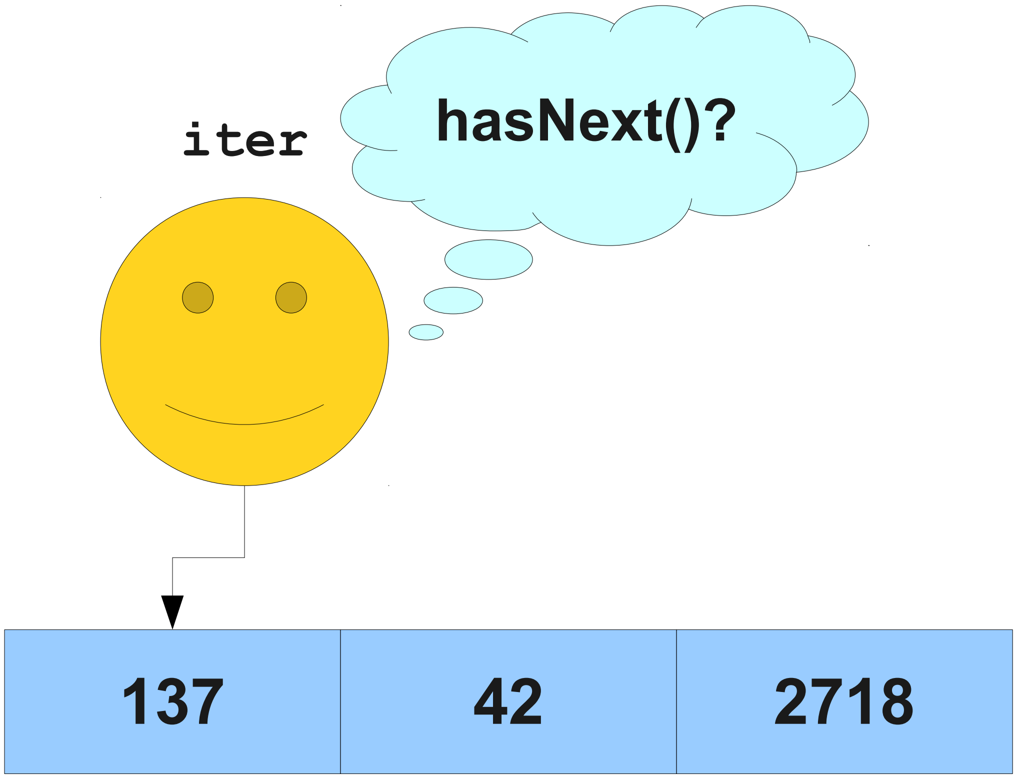

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hasNext()?

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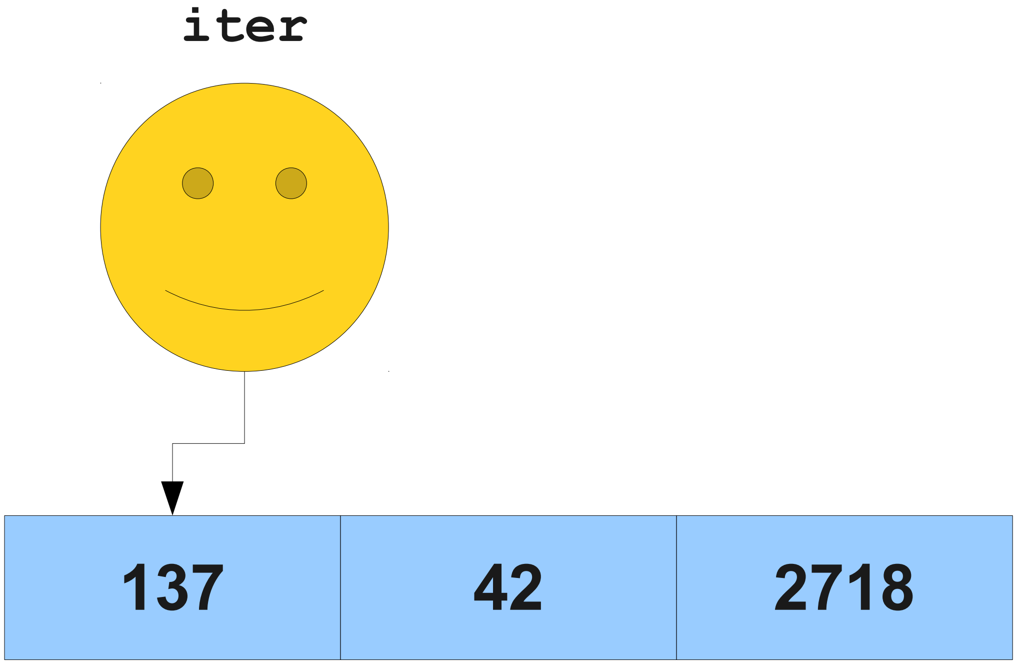

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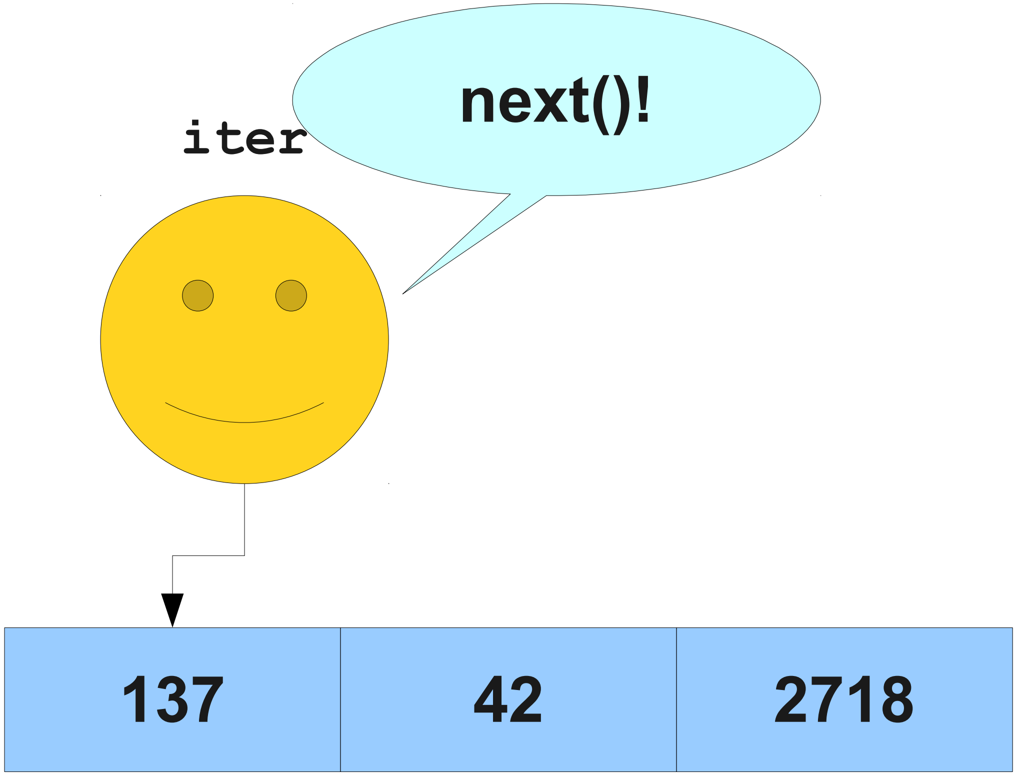

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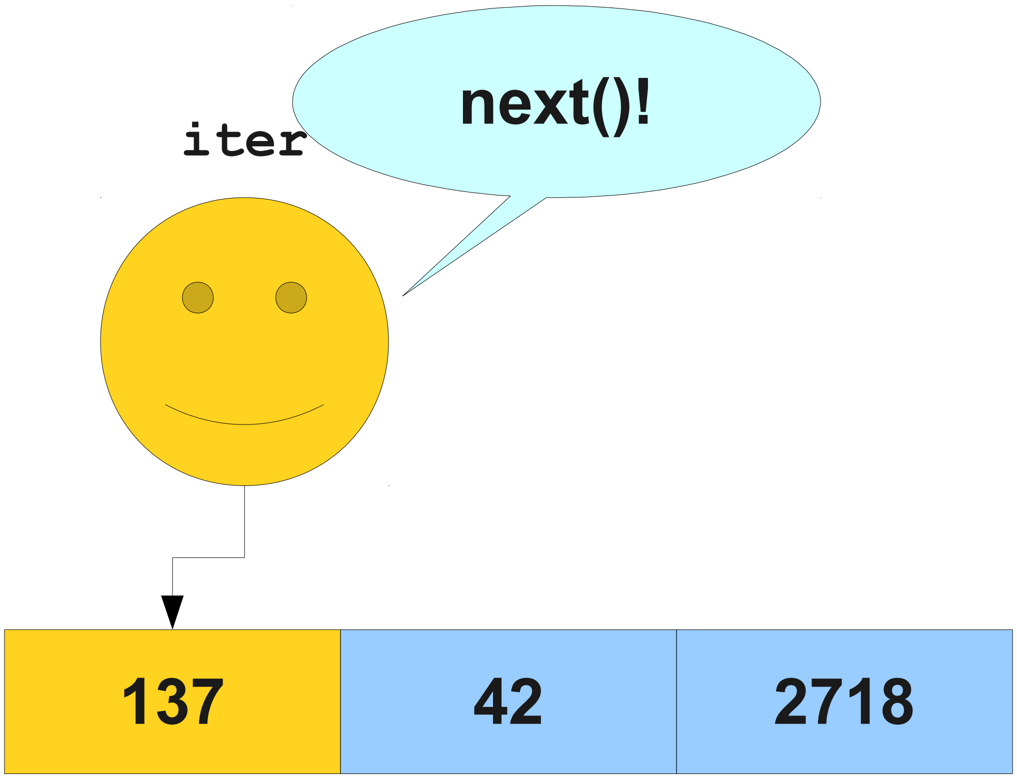

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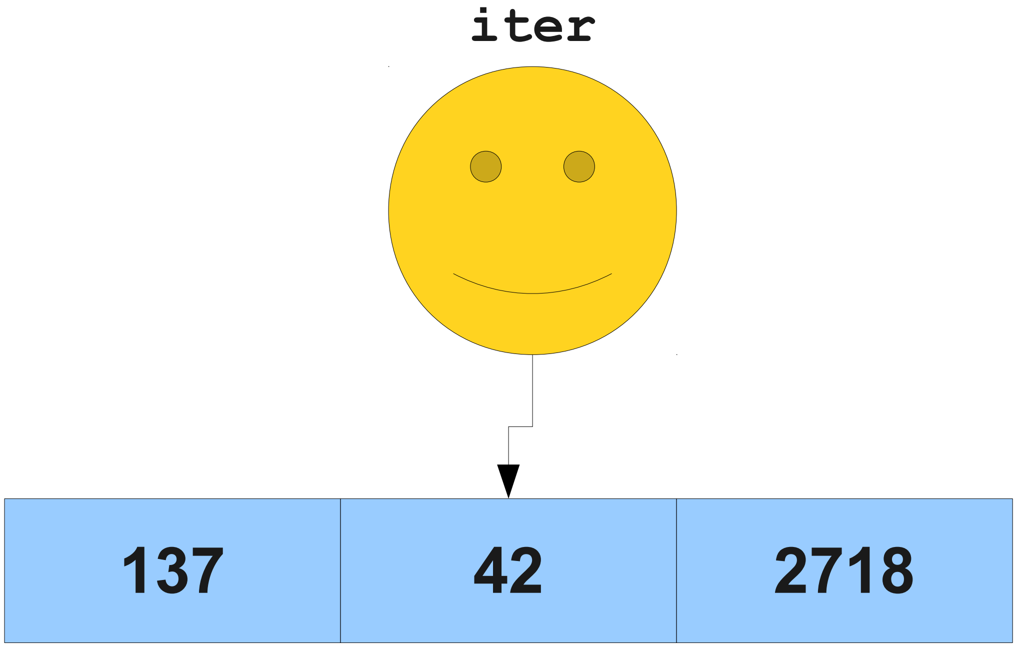

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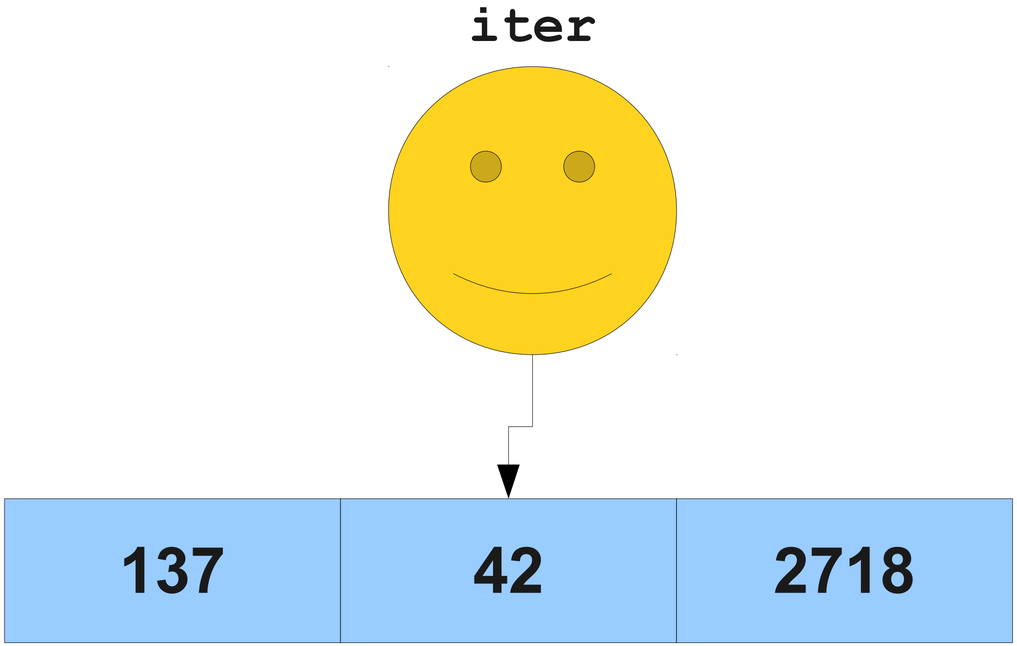

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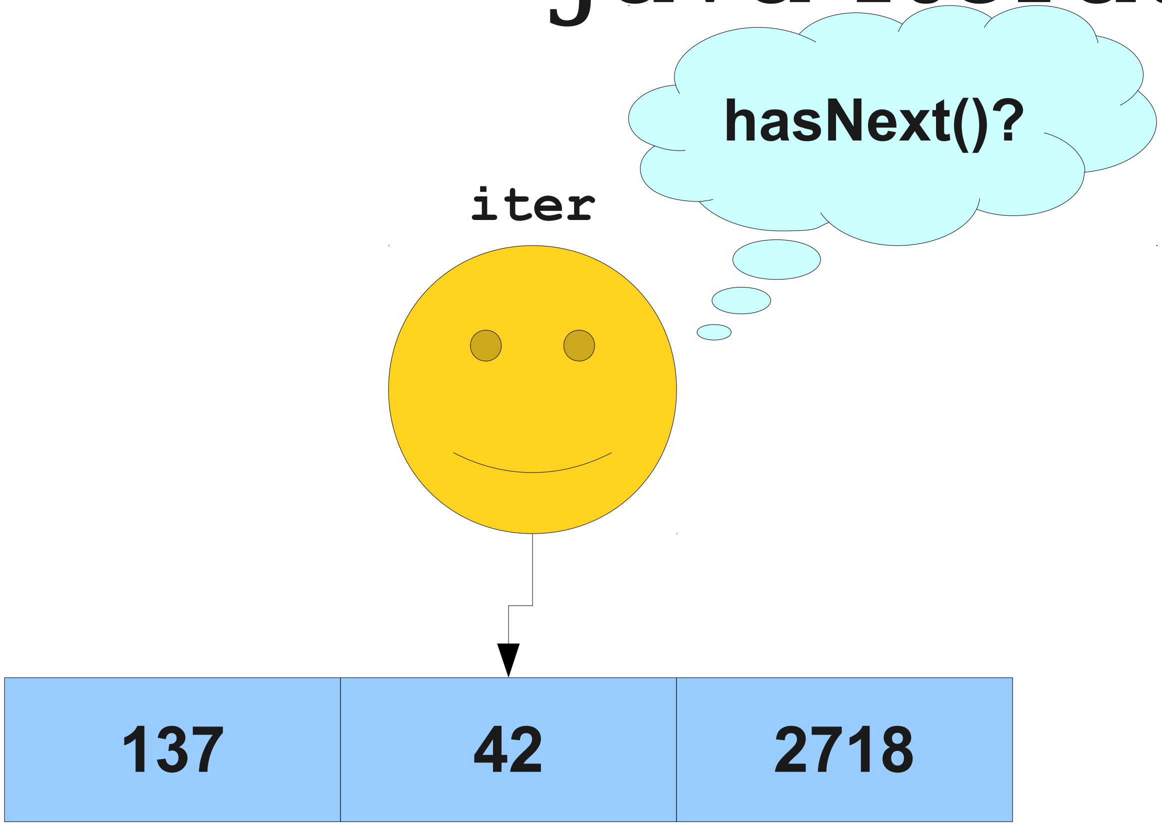

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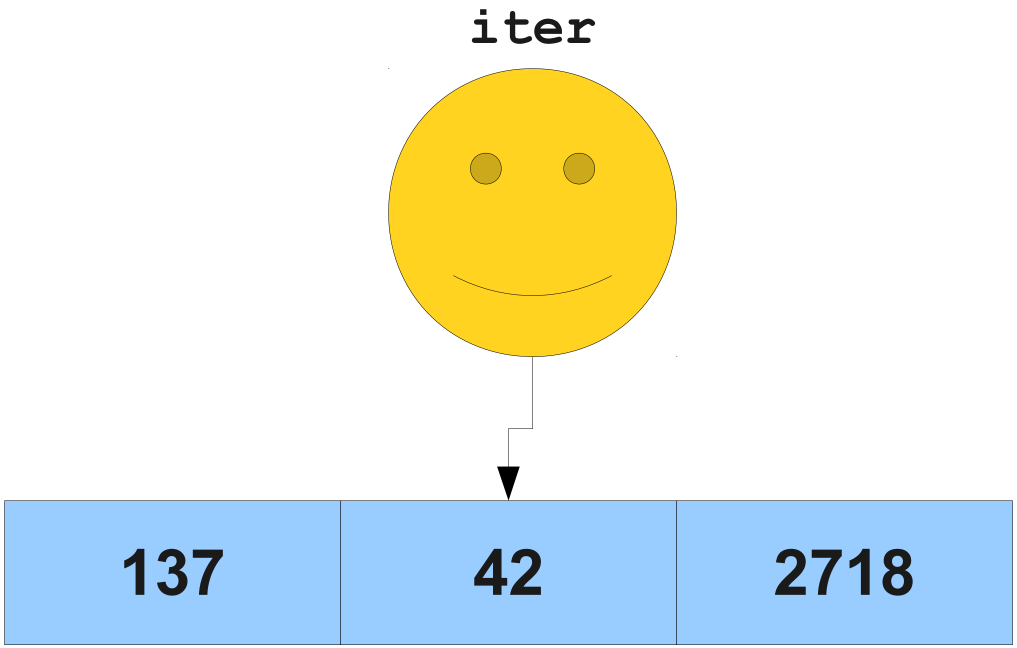

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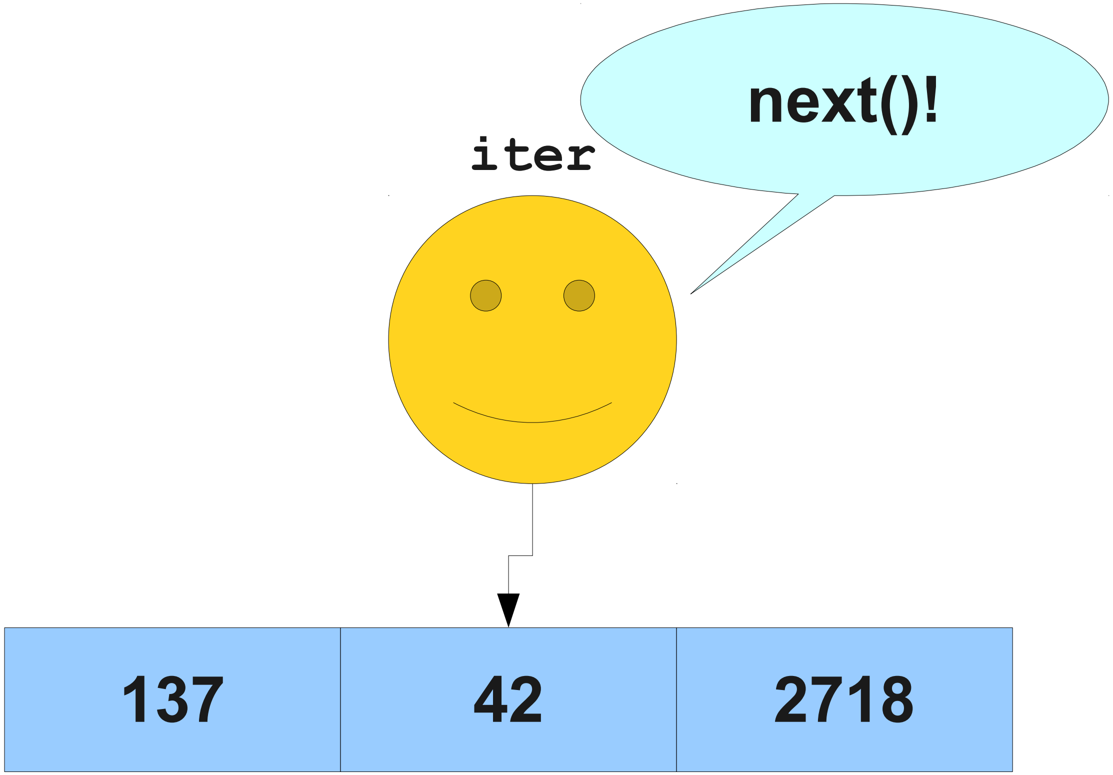

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next()!

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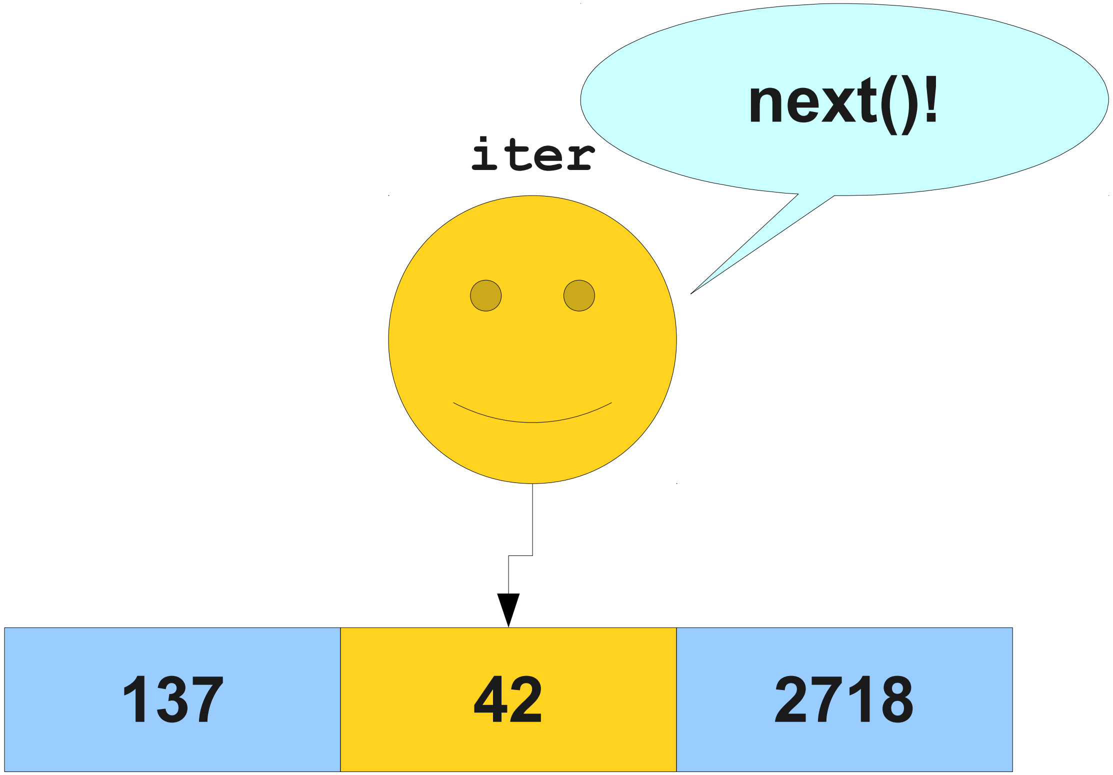

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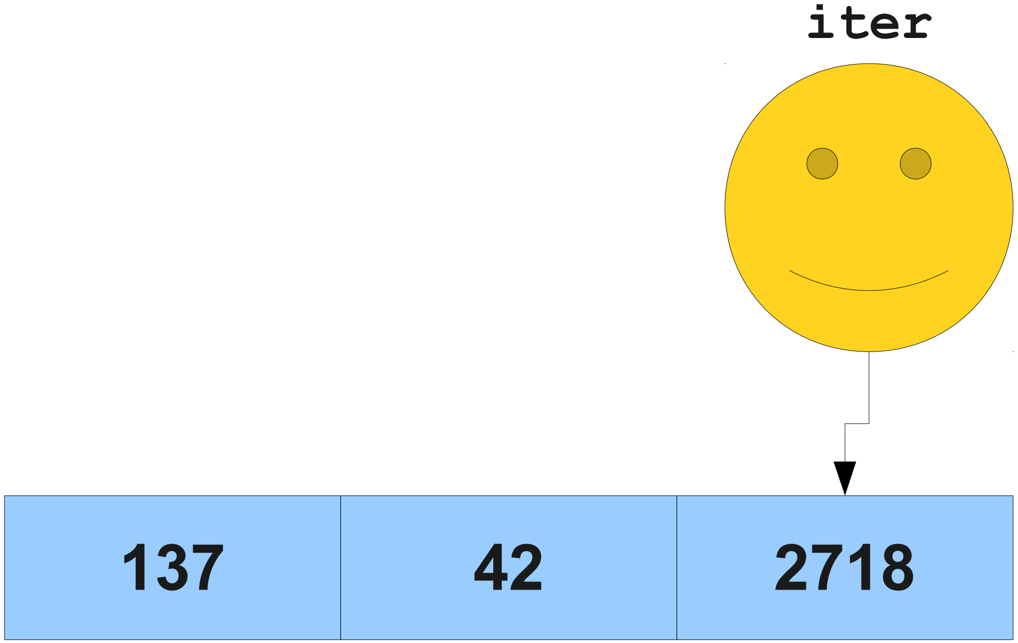

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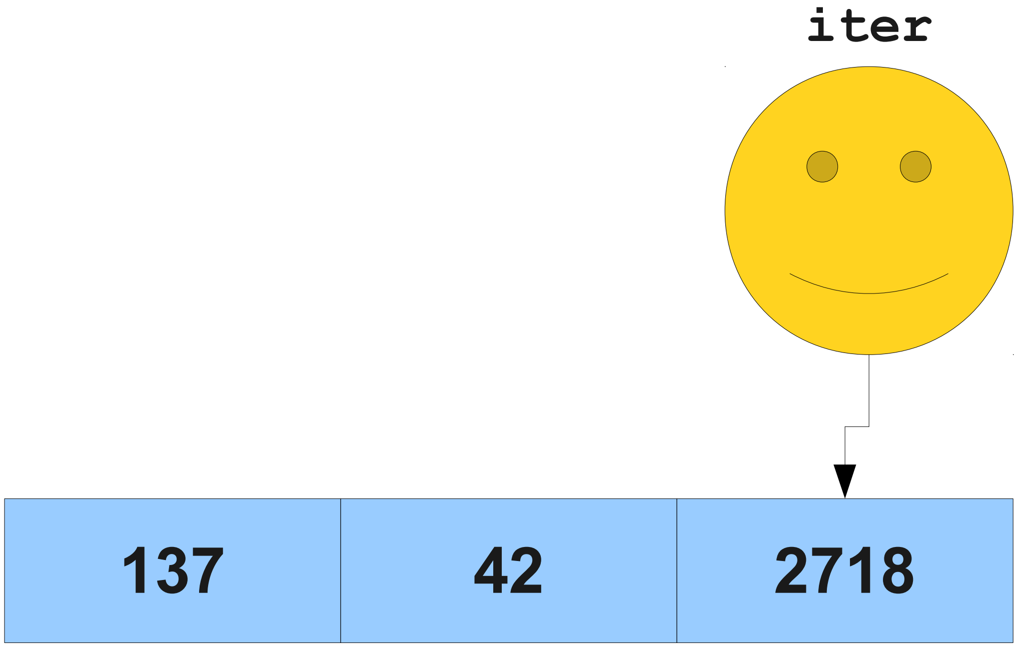

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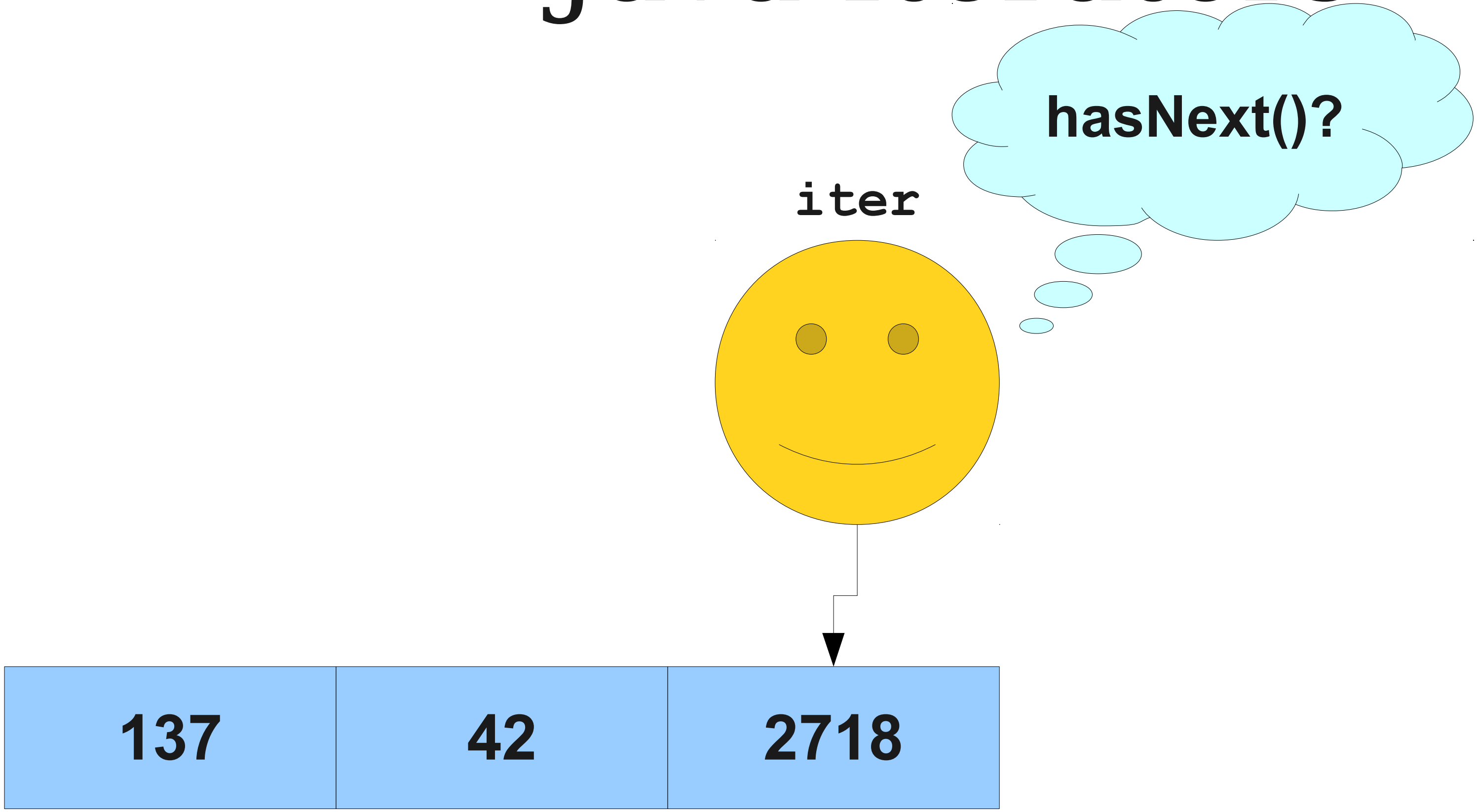

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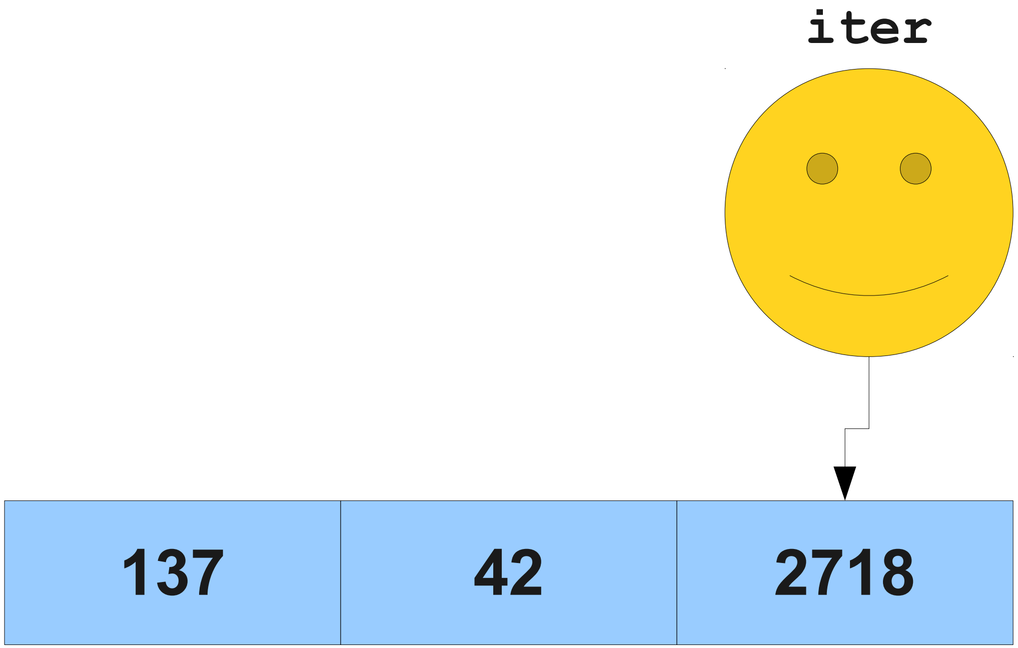

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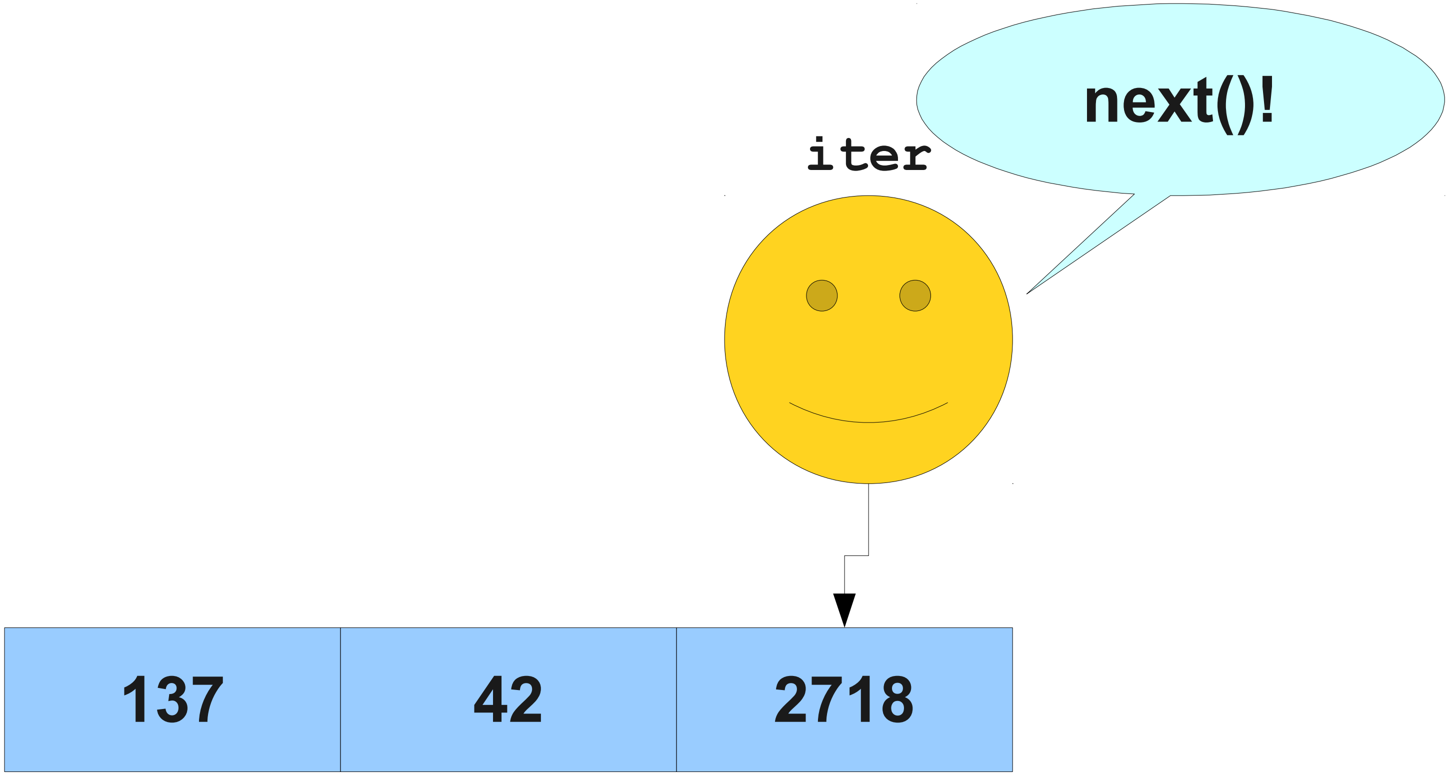

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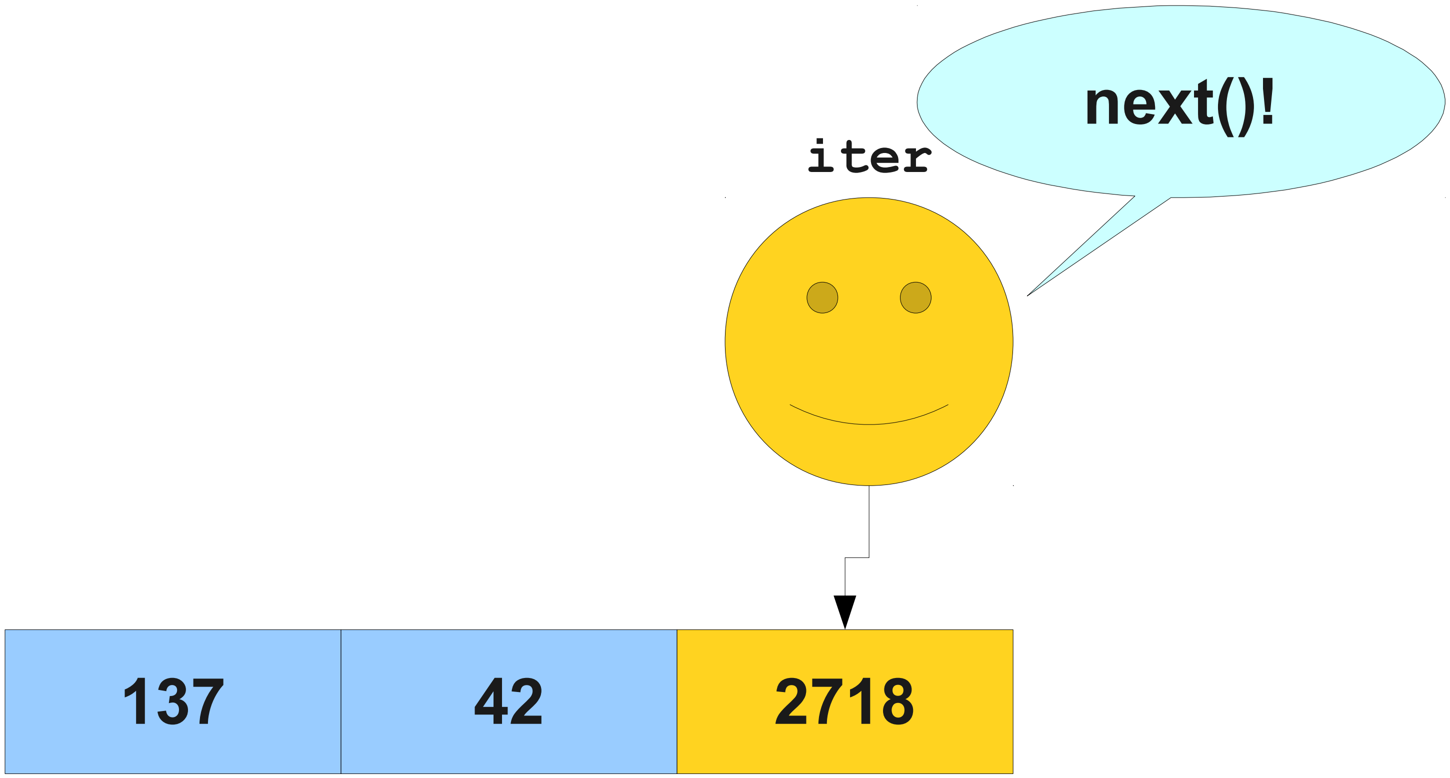

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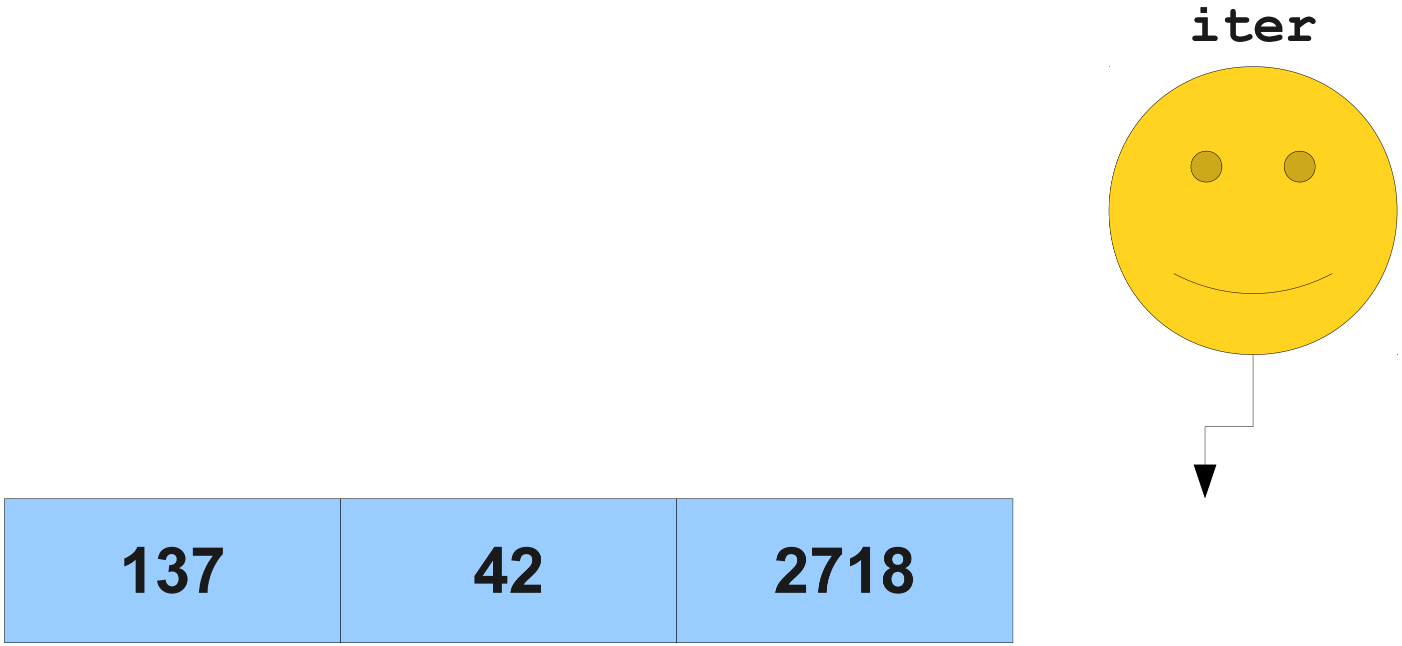

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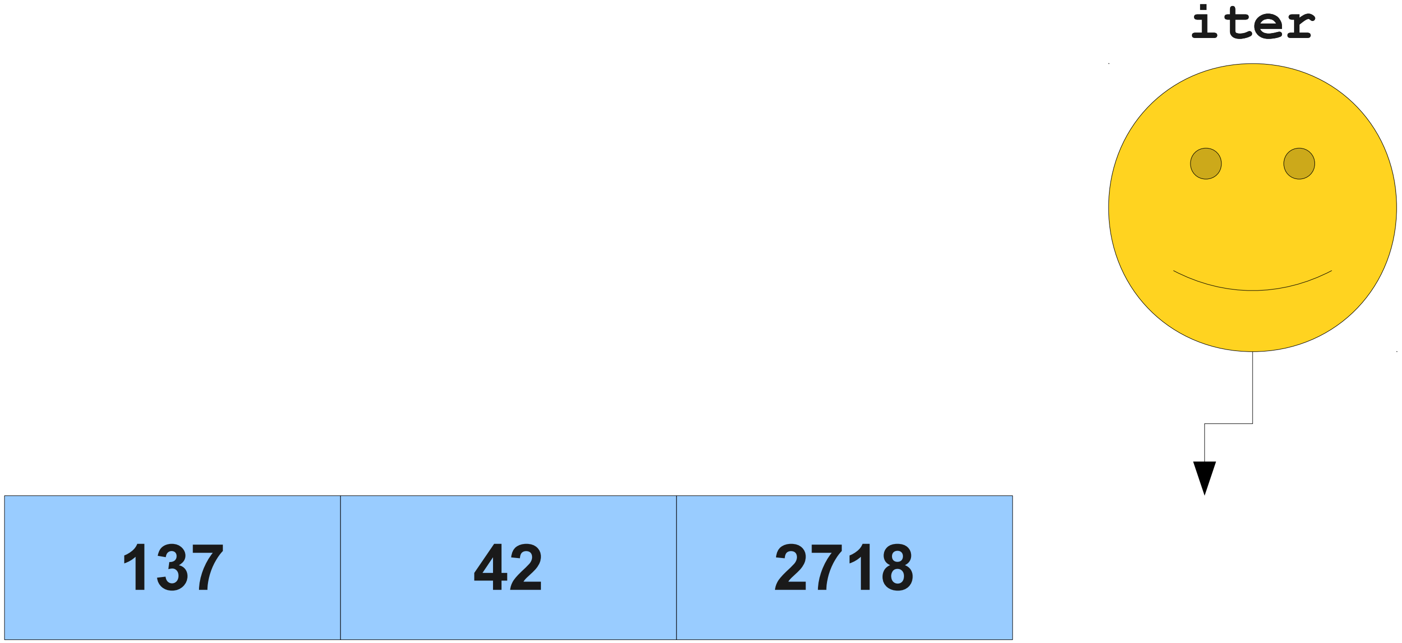

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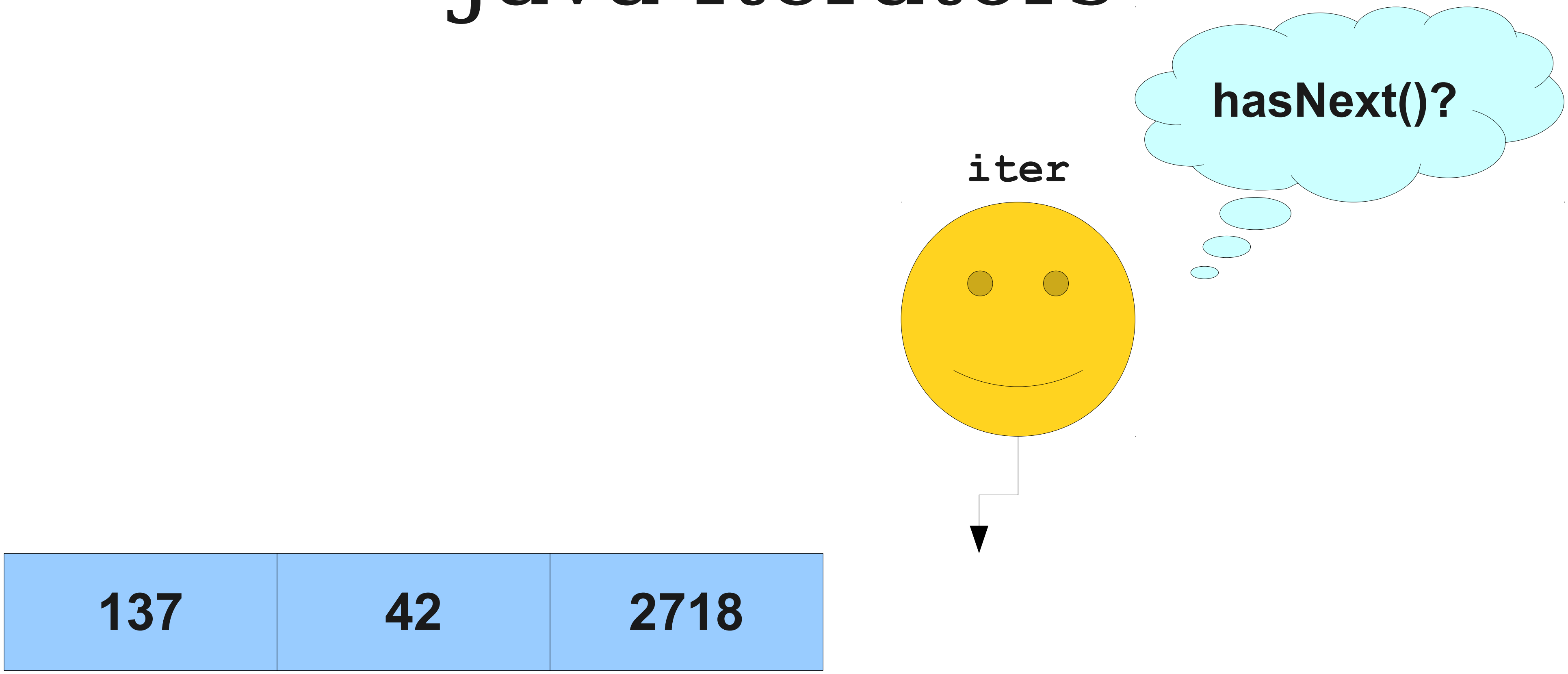

hasNext()?

iter

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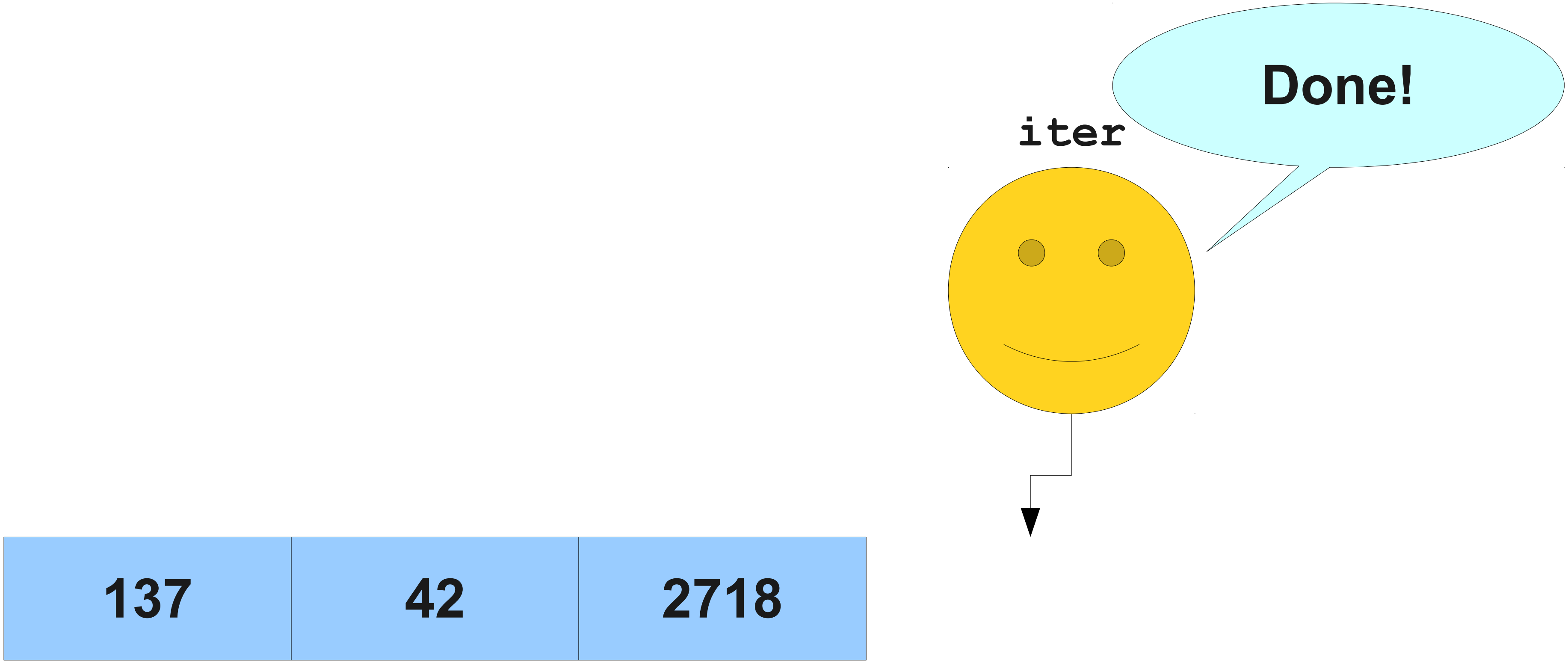

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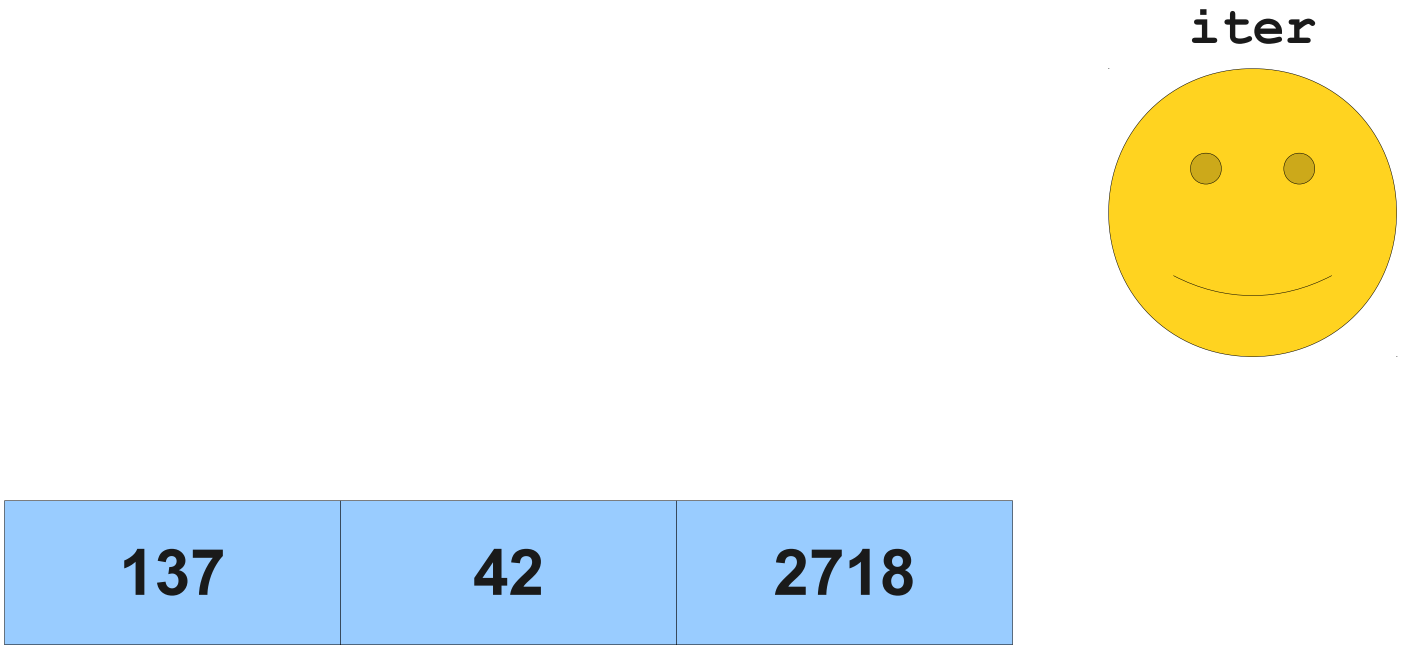

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A Use Case for Iterators

- Because all collections have iterators, a method can return an iterator to indicate “here is some data to look at.”
- Internally, that data can be stored in any format.
- Separates the **implementation** (how the class works) from the **interface** (how the class is used).

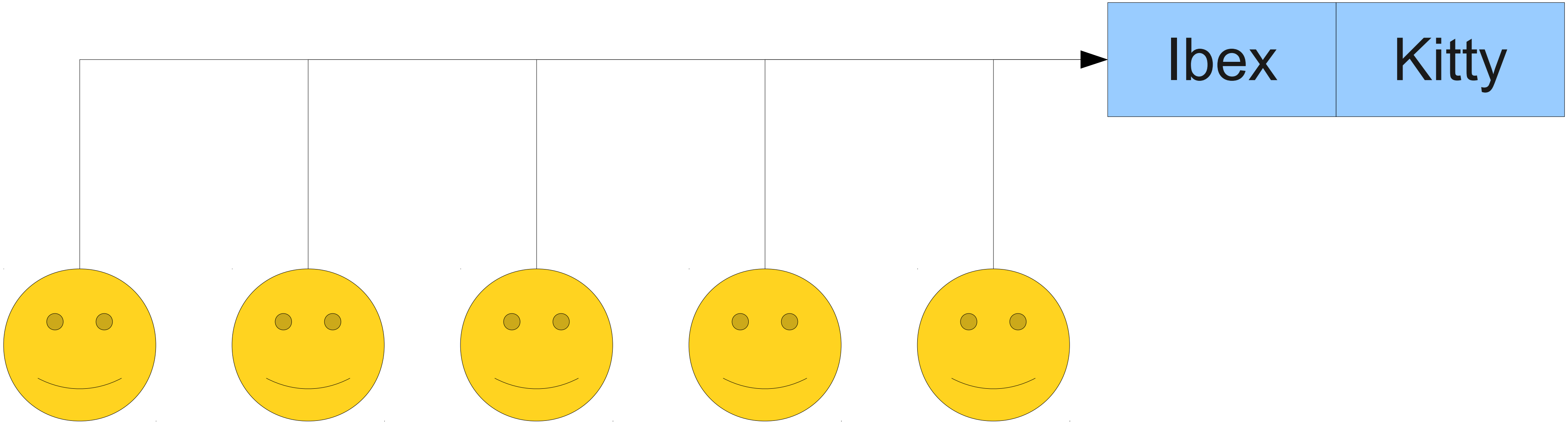
A Word of Warning

A Word of Warning

- The following will loop forever on a nonempty collection:

```
while (collection.iterator().hasNext()) {
    /* … */
}
```

- Every time that you call `.iterator()`, you get back a new iterator to the start of the collection.



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while (c
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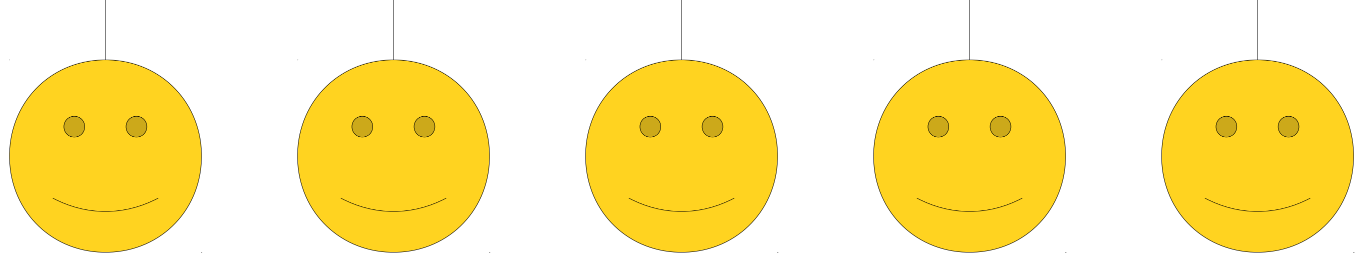
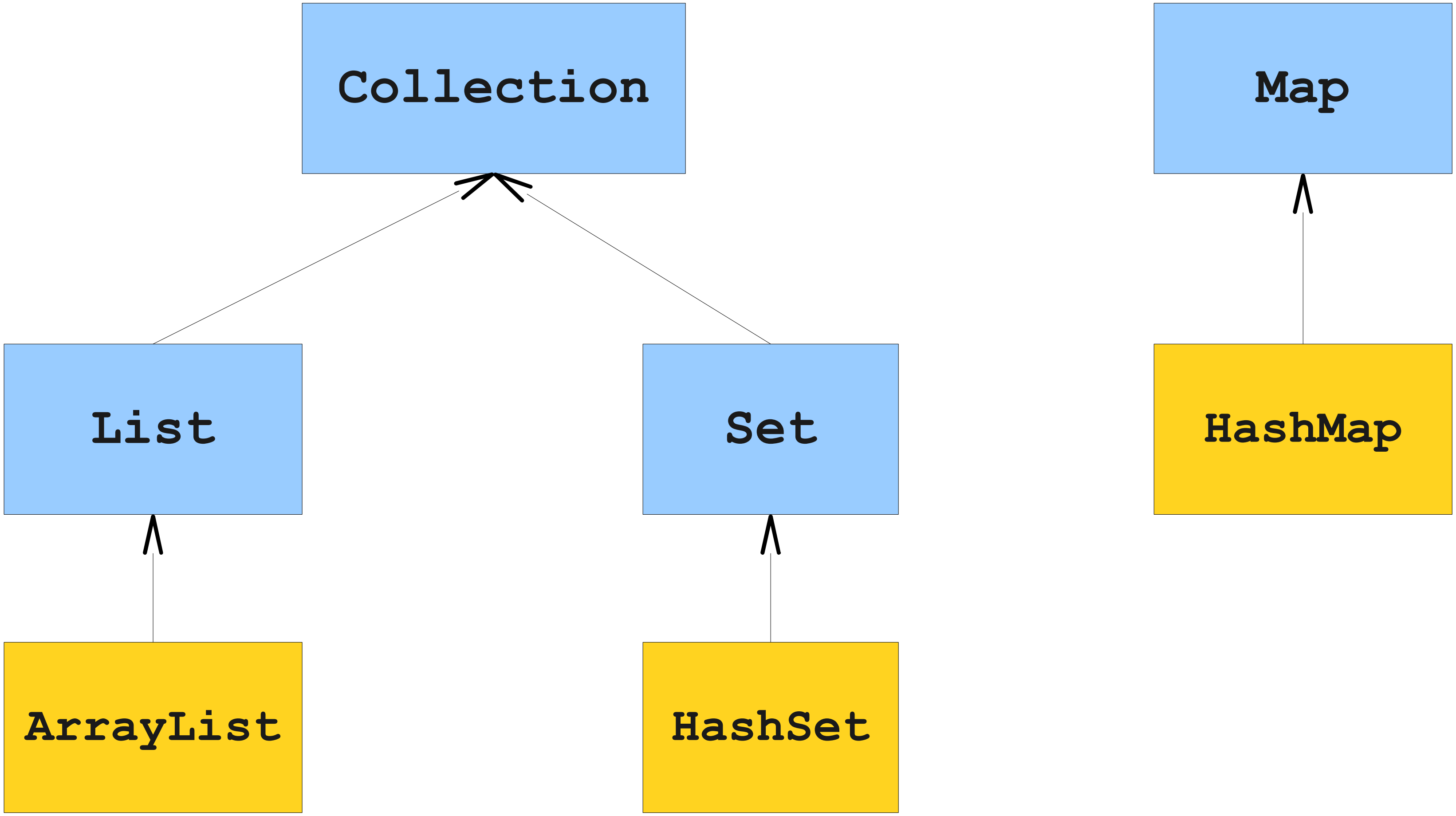


The Collections Framework



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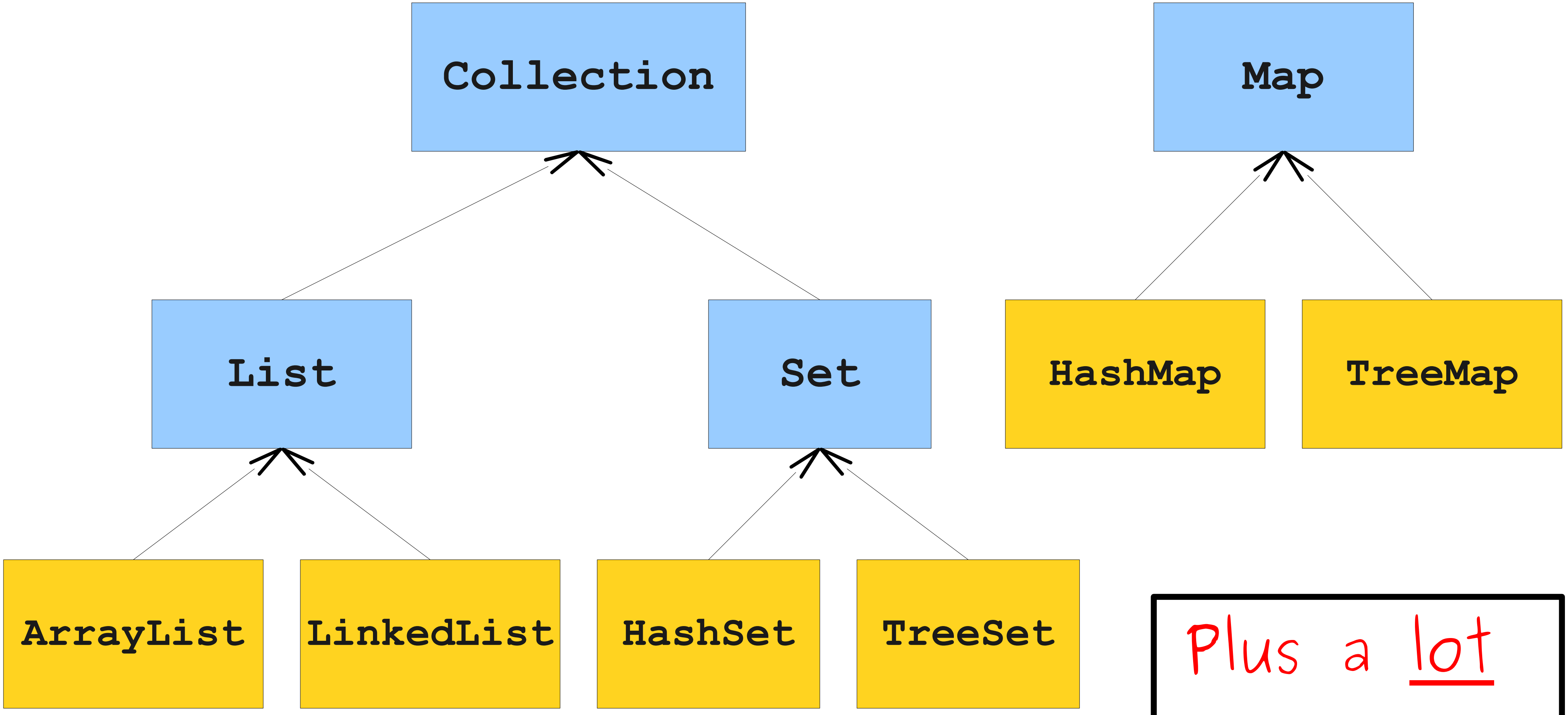
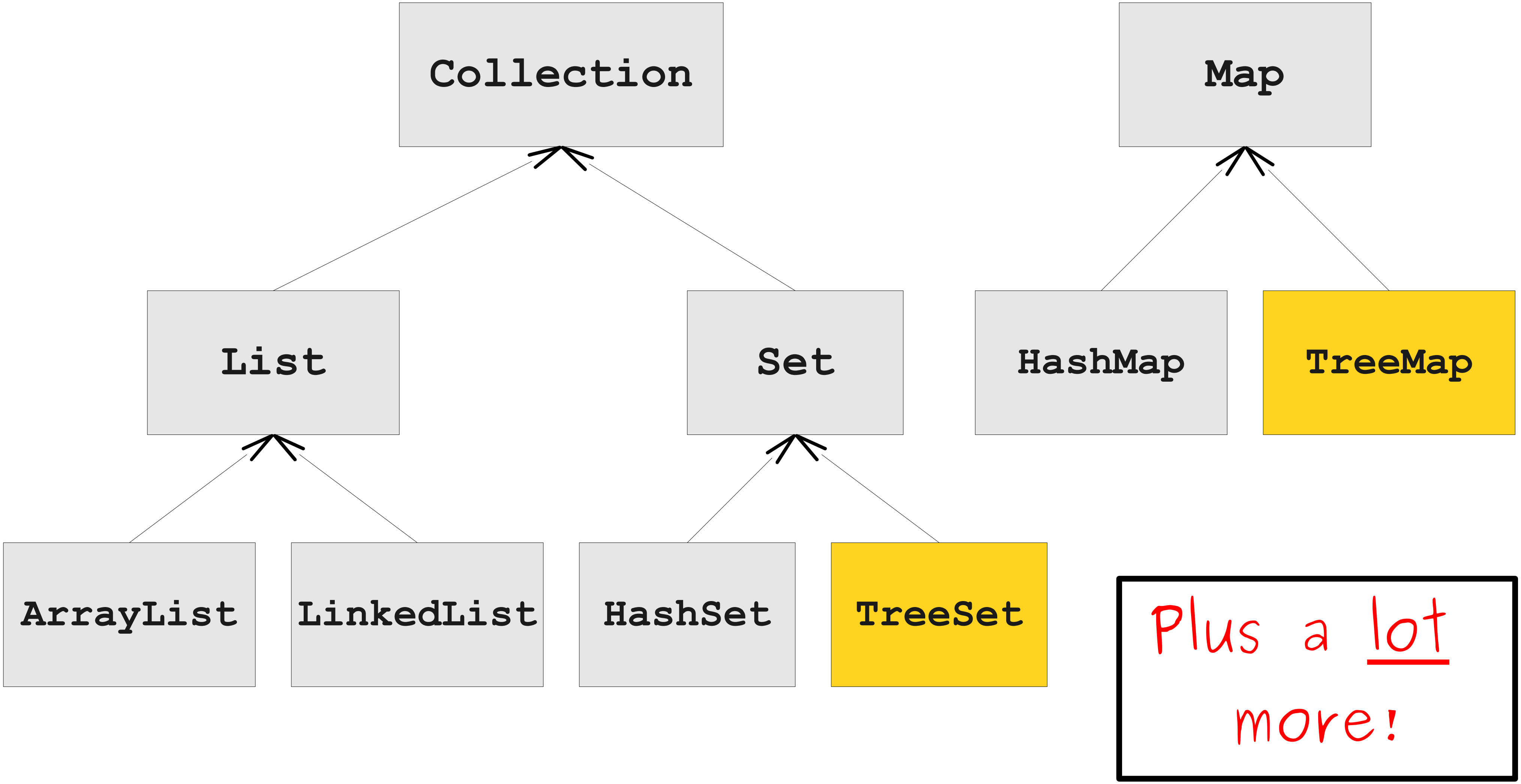


Plus a lot more!

The Collections Framework



Plus a lot more!

`TreeSet`

- **`TreeSet`** is similar to **`HashSet`**, except that the values in a **`TreeSet`** are stored in sorted order.
- Iterating over a **`TreeSet`** guarantees that the elements are visited in ascending order.
- **`TreeSet`** is a bit slower than **`HashSet`**, so it's best used only when you really need things in sorted order.

Levels of Specificity

- To create a map, set, or list, you must choose a specific implementation (i.e. **`ArrayList`**, **`HashMap`**, etc.)
- You can store maps, sets, or lists in variables of type **`Map`**, **`Set`**, or **`List`**.
  - Similar to **`GObject`** versus **`GOval`**, **`GRect`**, etc.
- Lets you say “I just need key/value pairs” rather than “I need key/value pairs specifically stored as a **`HashMap`**”

`TreeMap`

- **`TreeMap`** is similar to **`HashMap`**, except that the *keys* in a **`TreeMap`** are stored in sorted order.
- Like **`TreeSet`**, iteration over the keys visits the keys in sorted order.
- The **`TreeMap`** has several impressive methods that don't exist on the normal **`HashMap`**.
- There is slight performance cost to using **`TreeMap`**.