Collections

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

The Collections Framework

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The three major ways of organizing data are

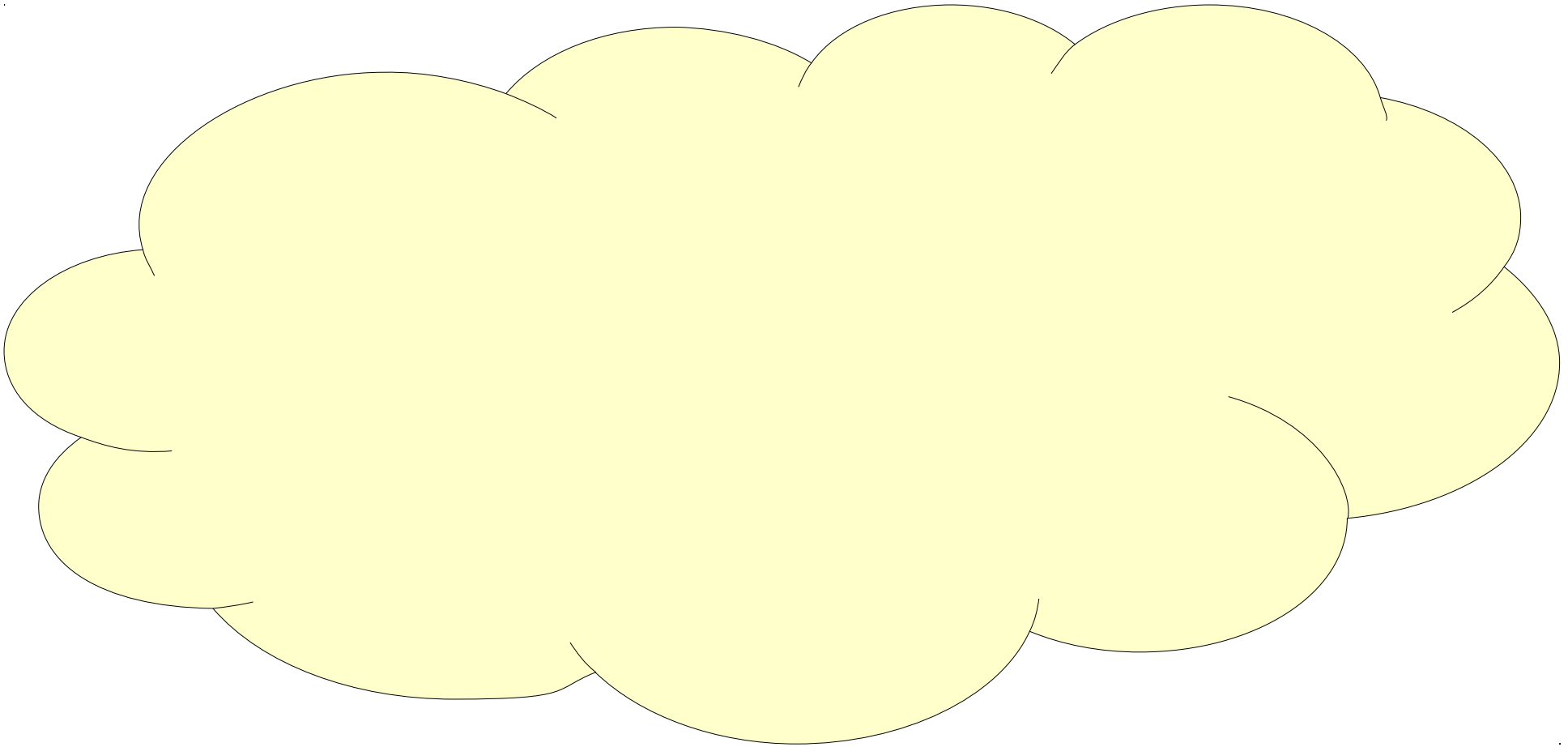
- **`Set`**s, which store unordered data,

  `List`s, which store sequences, and

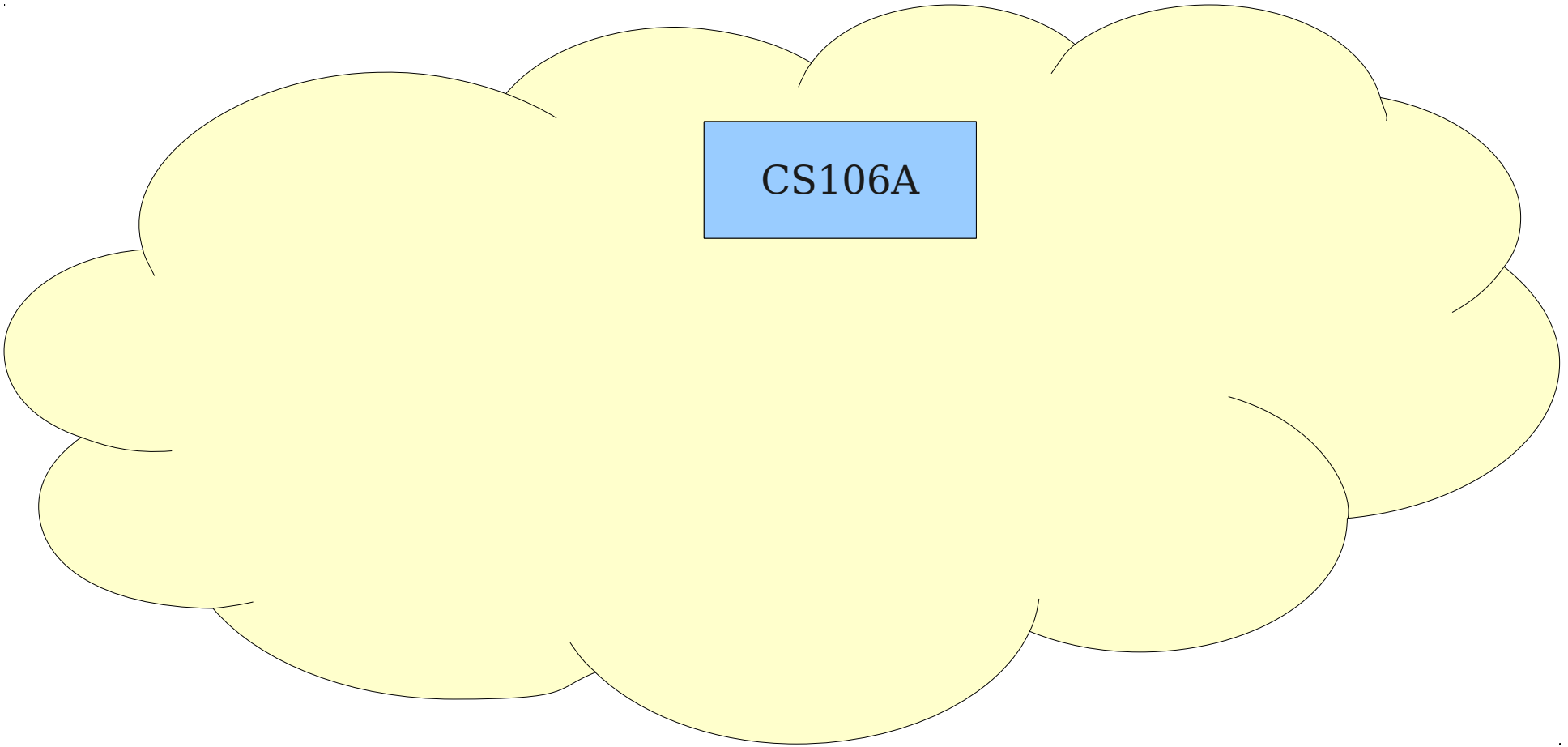
  `Map`s, which store key/value pairs.

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?”



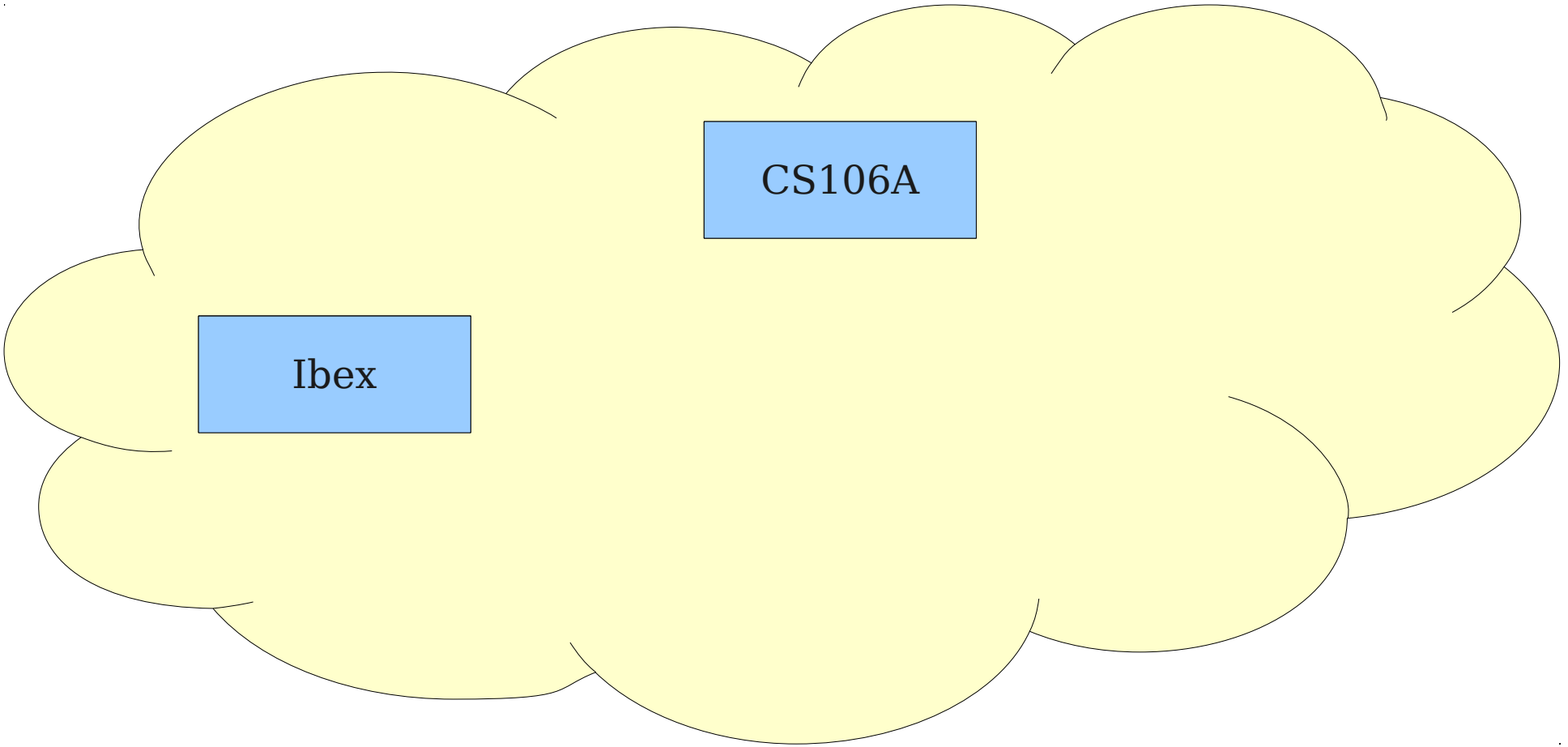
```
HashSet<String> mySet = new HashSet<String>();
```



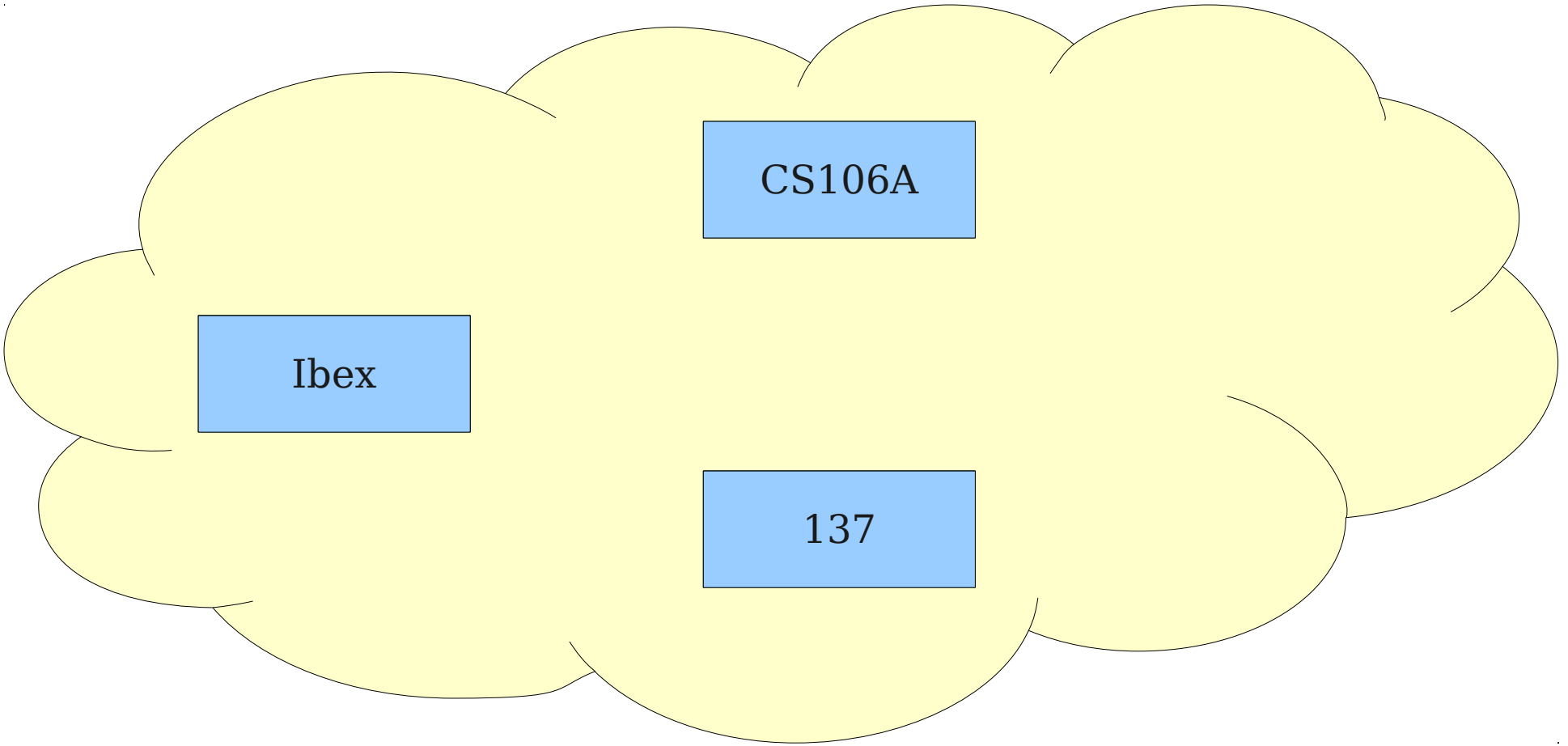

```
HashSet<String> mySet = new HashSet<String>();
mySet.add("CS106A");
```

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

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




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

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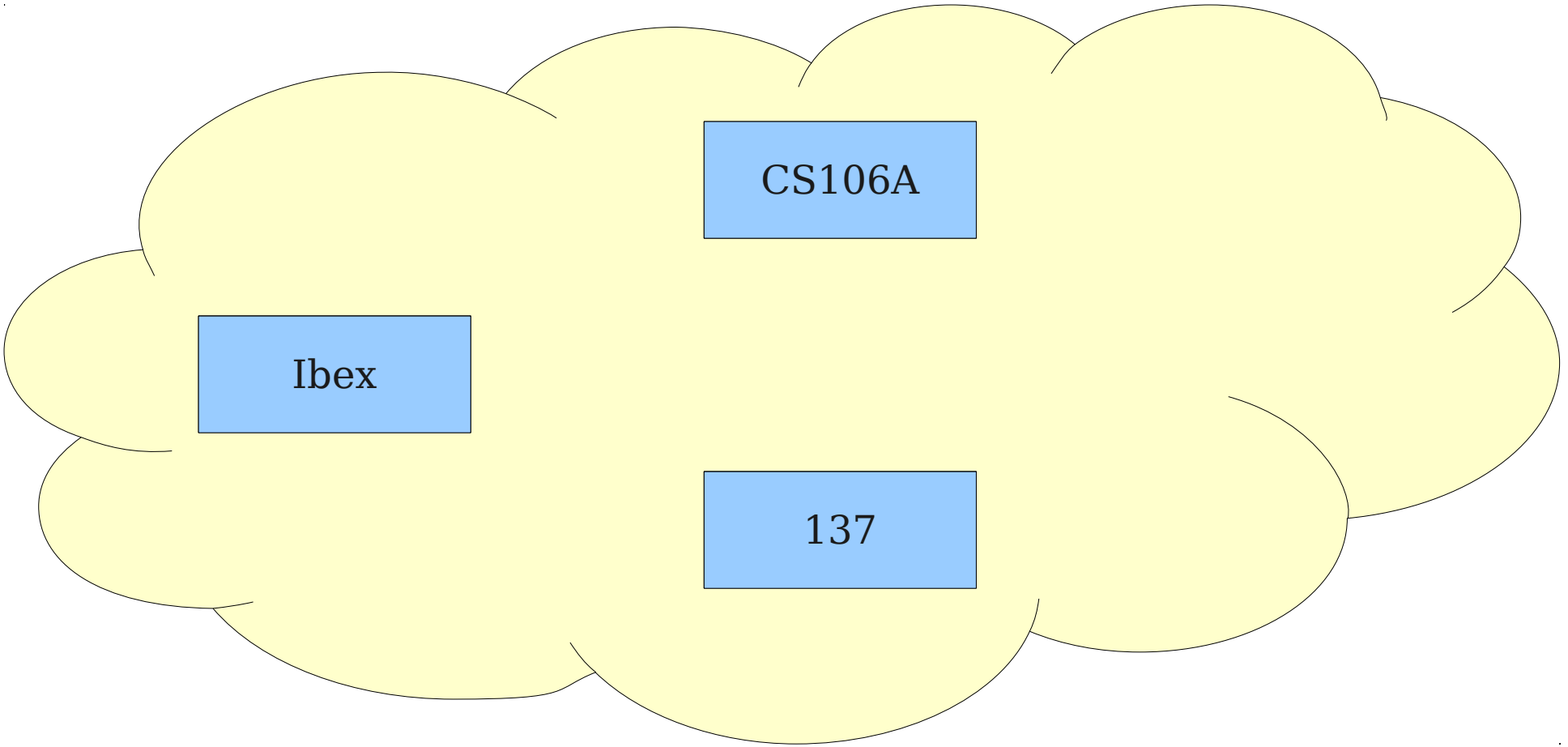
HashSet<String> mySet = new HashSet<String>();
mySet.add("CS106A");
mySet.add("Ibex");
mySet.add("137");
```

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```
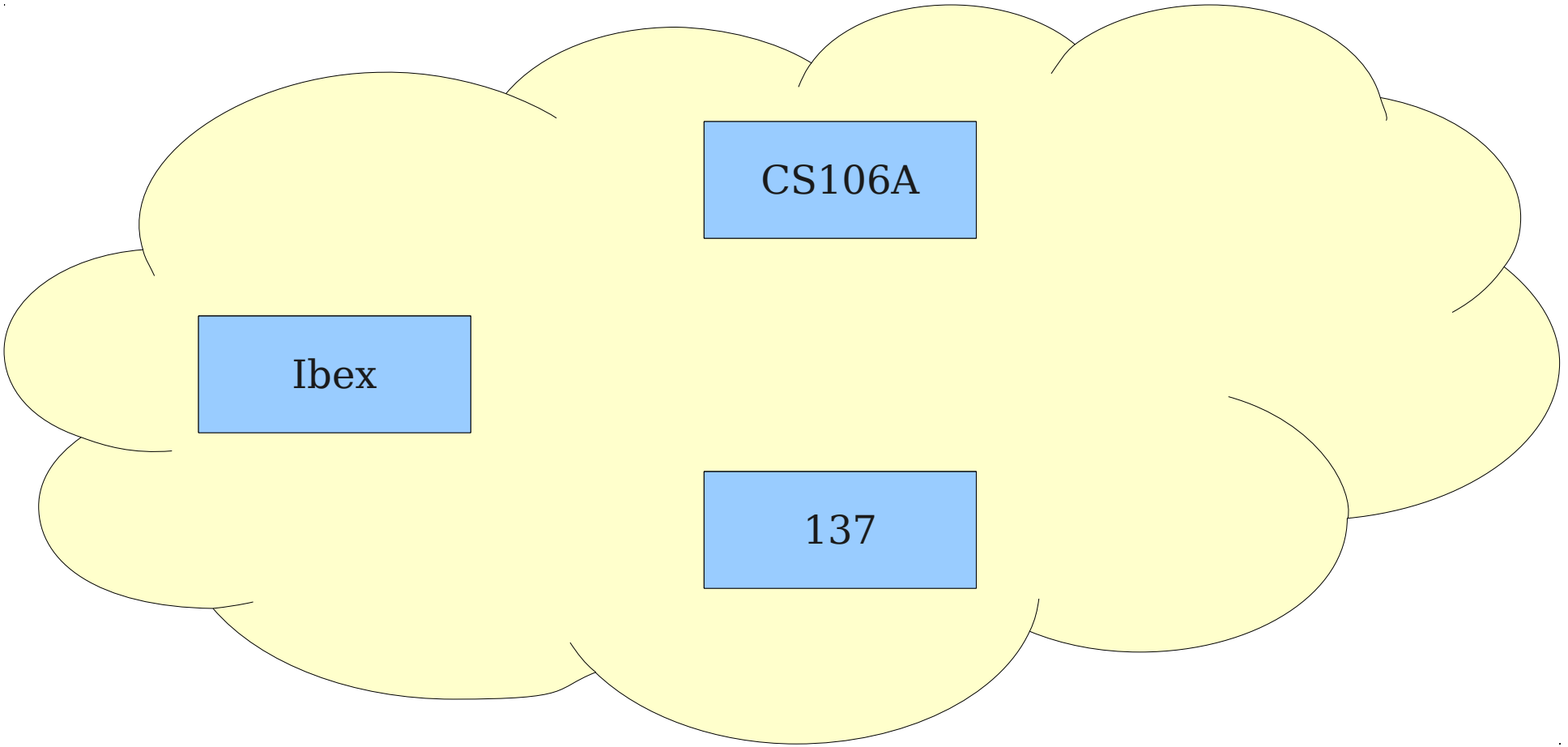

If you **add** a value pair where the value exists, nothing happens.

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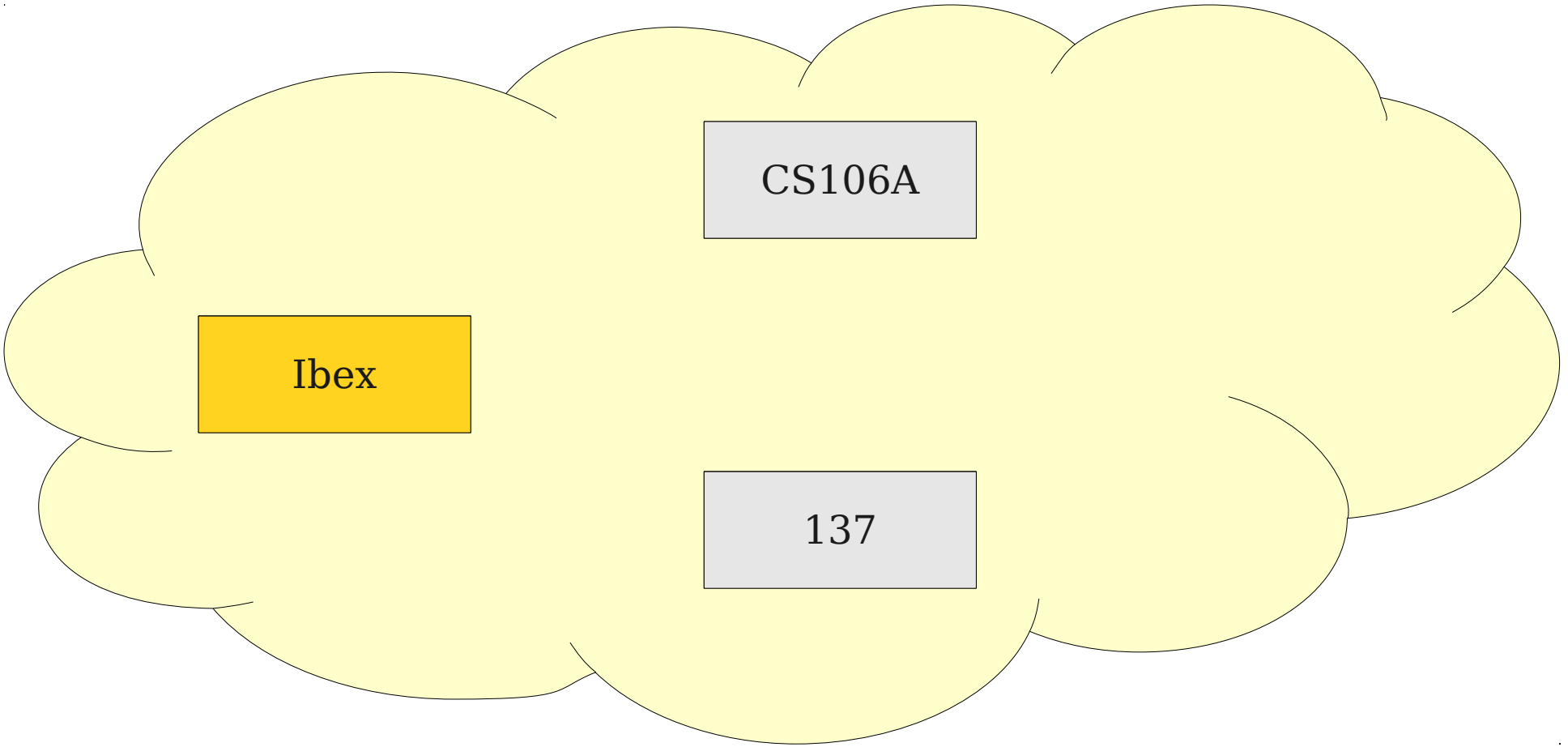
HashSet<String> mySet = new HashSet<String>();
mySet.add("CS106A");
mySet.add("Ibex");
mySet.add("137");
mySet.add("CS106A");

mySet.contains("Ibex");
```

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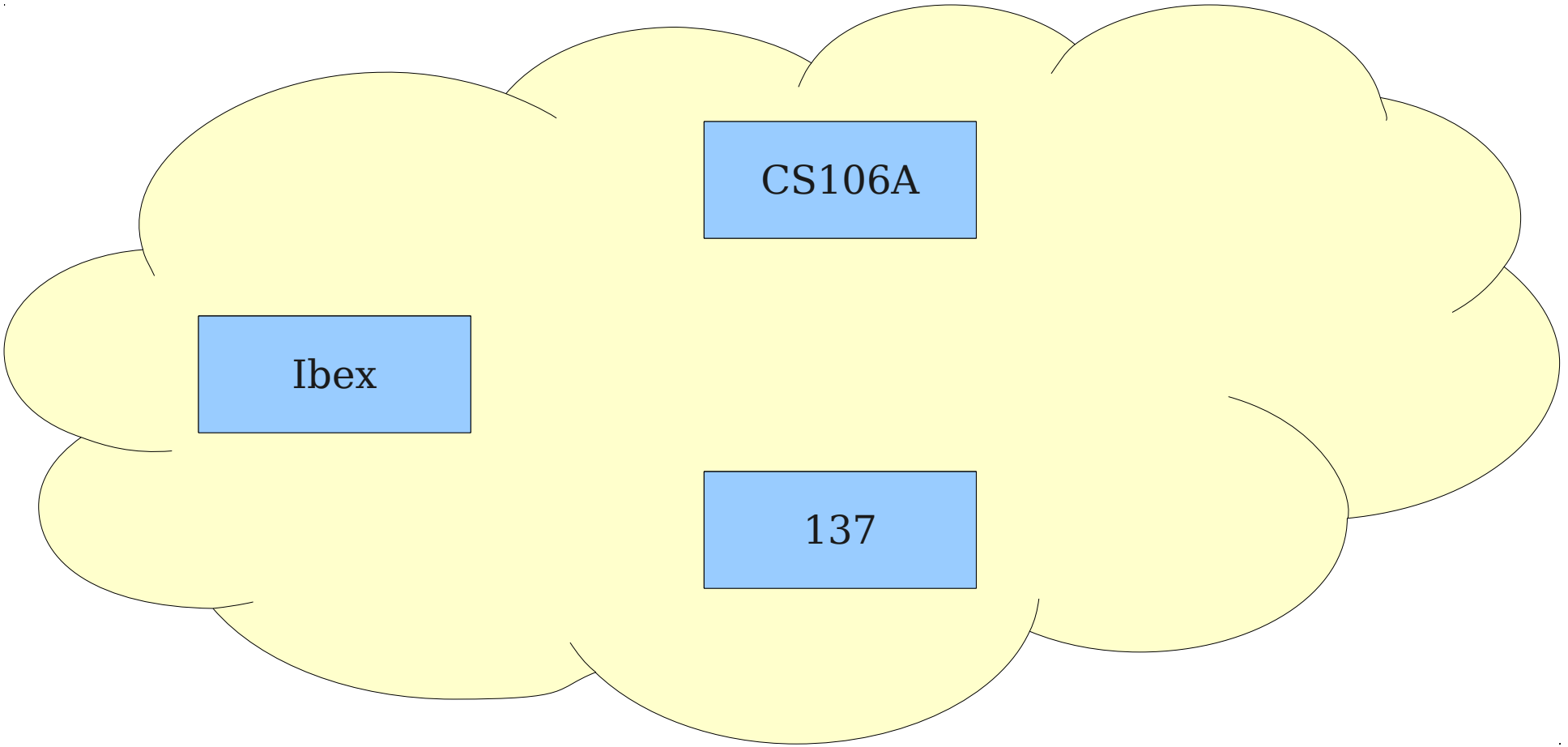
To see if a value exists:

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

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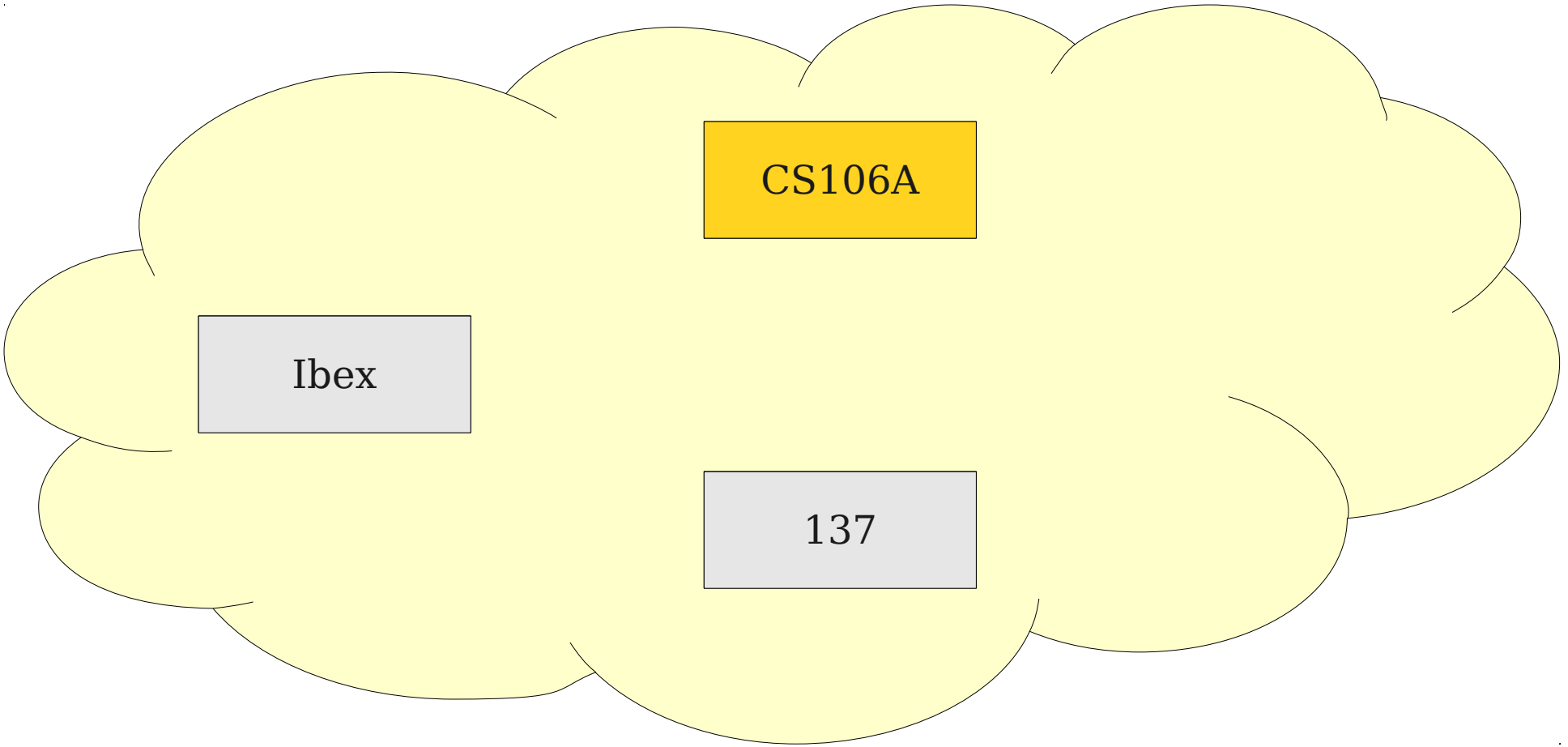


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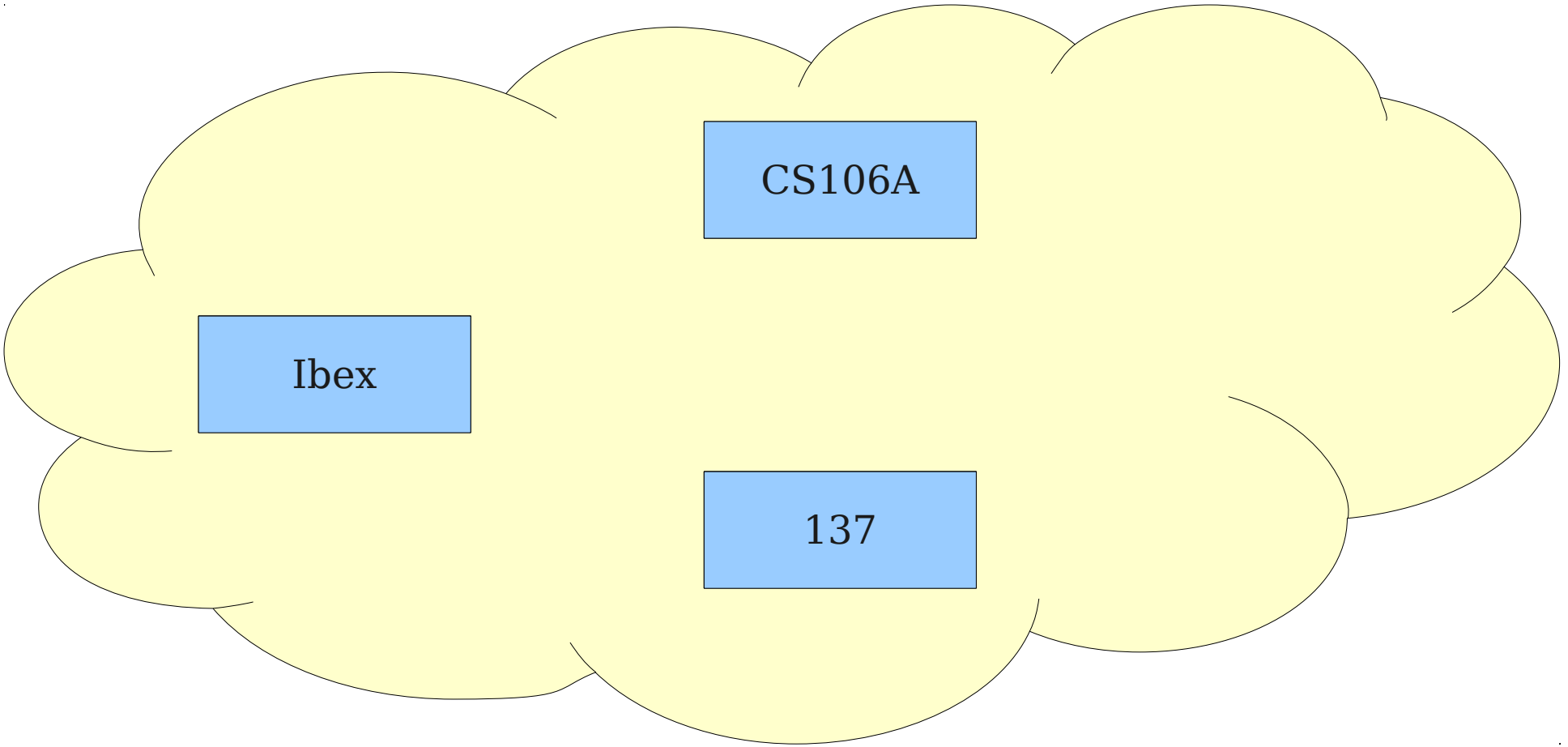


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mySet.contains("<(^_^)>");
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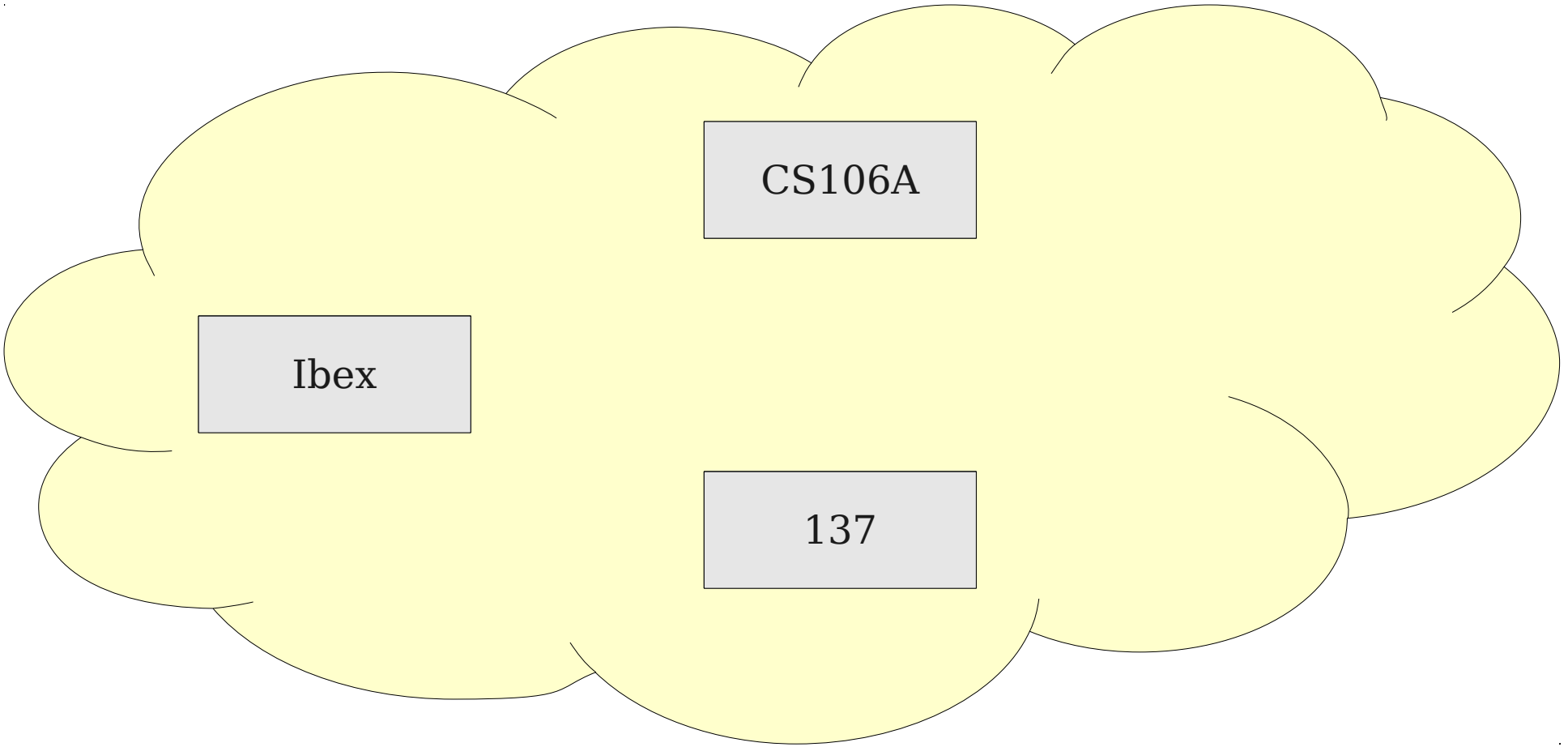


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Basic `Set` Operations

- To insert an element:

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

- To check whether a value exists:

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

- To remove an element:

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

Word Skips

- Begin with any word you'd like.
- Choose a word whose first letter is the same as the last letter of your current word.
- Repeat until you get bored.

Word Skips

CARRO**T**

TOMAT**O**

OKR**A**

ASPARAGU**S**

SQUAS**H**

HORSERADISH

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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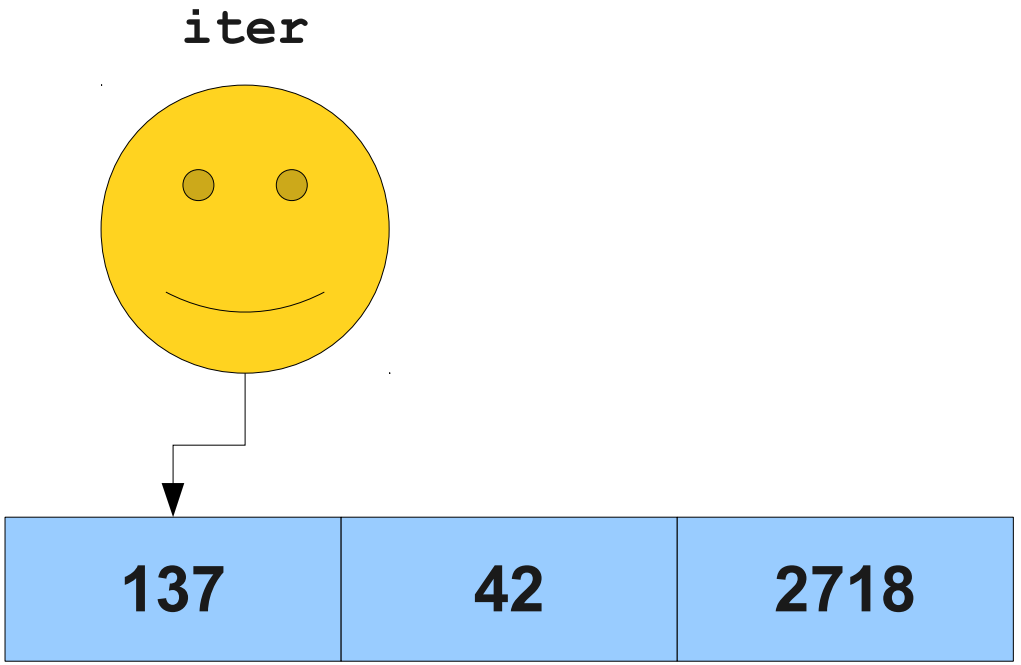


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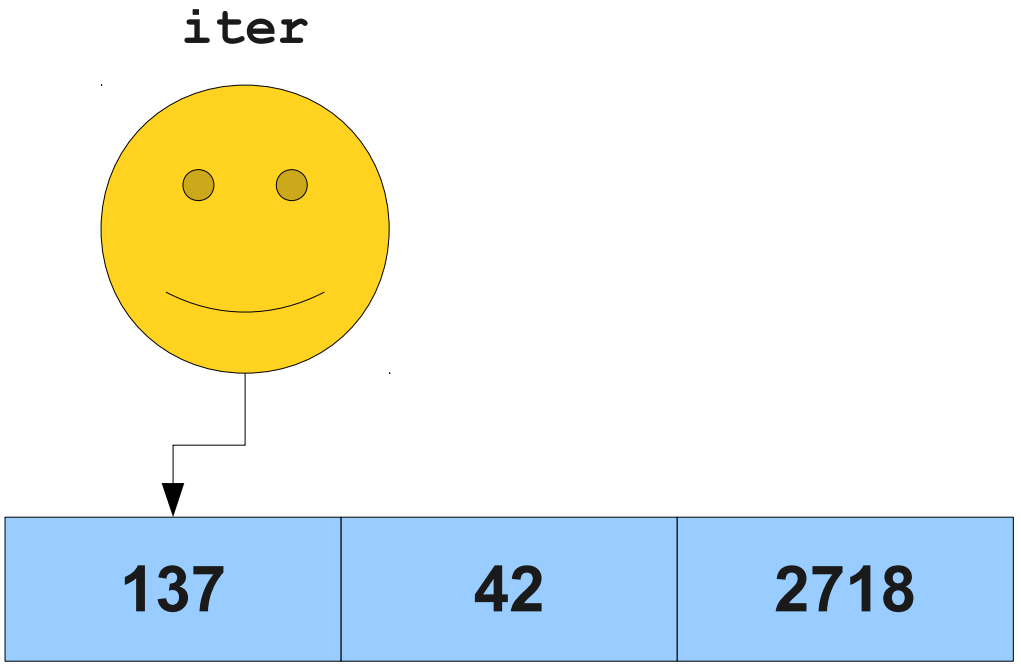


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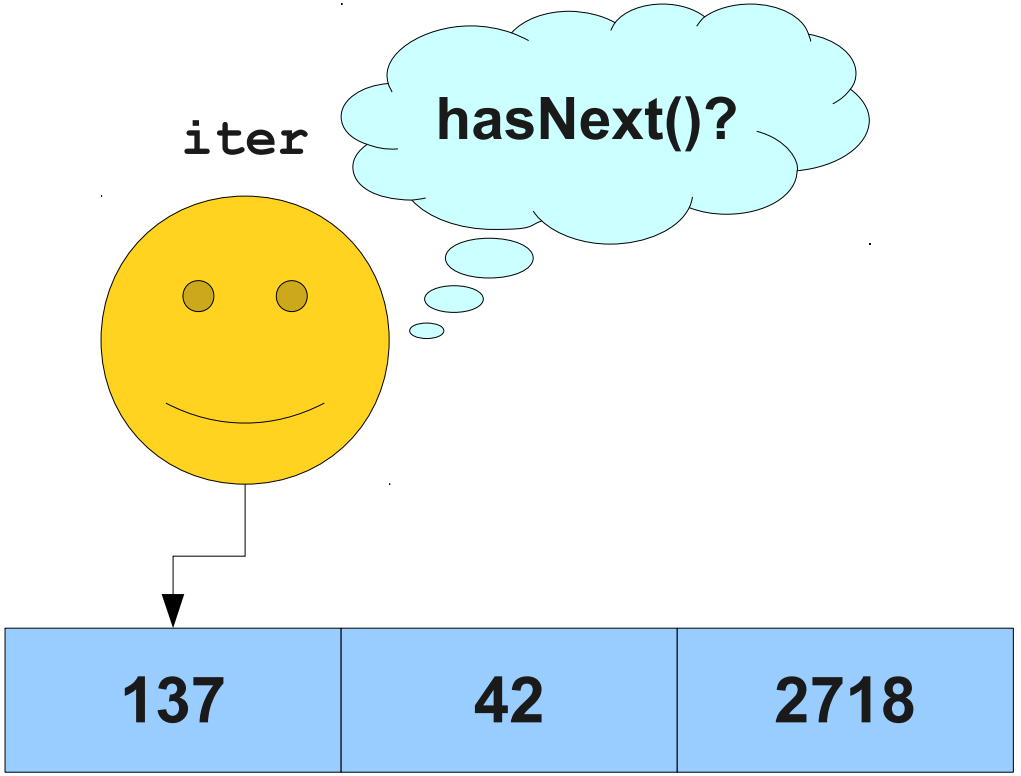


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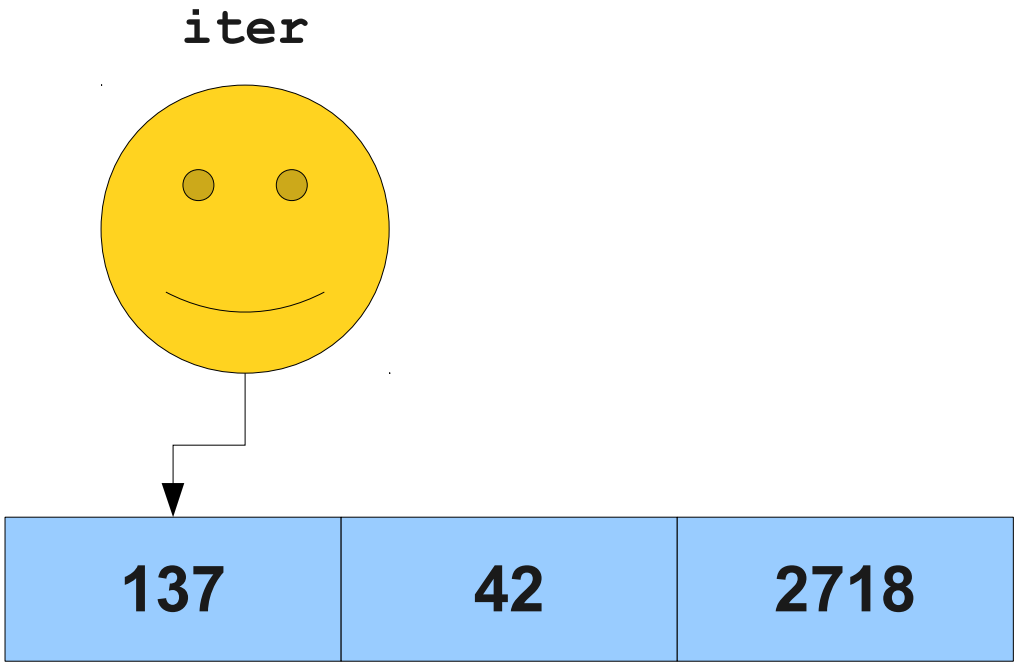


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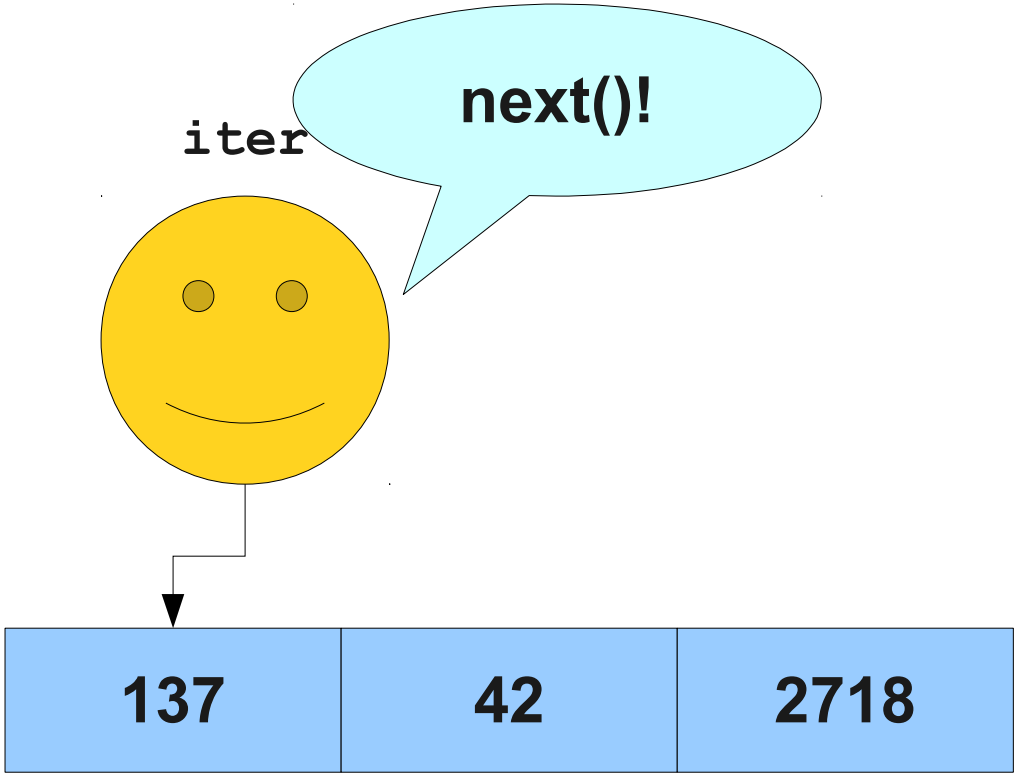


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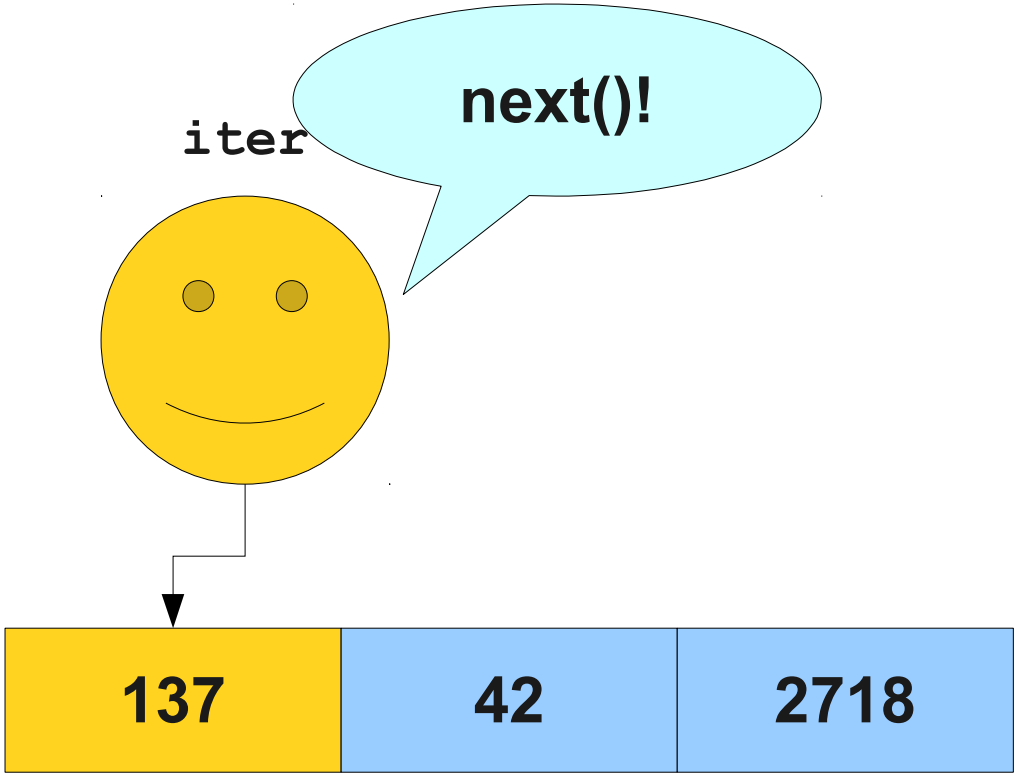


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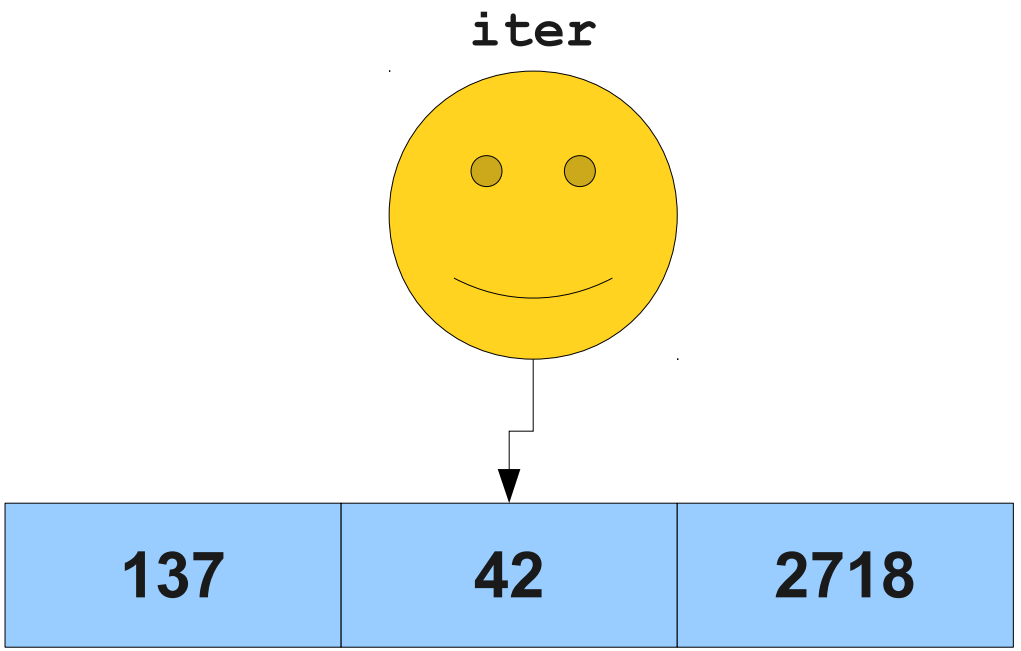


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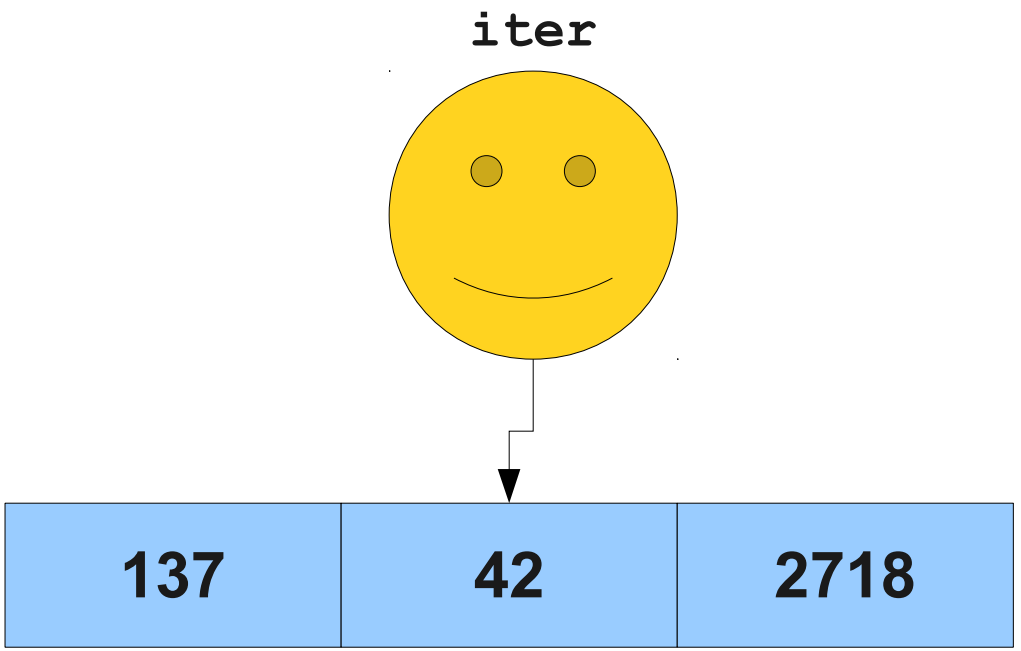


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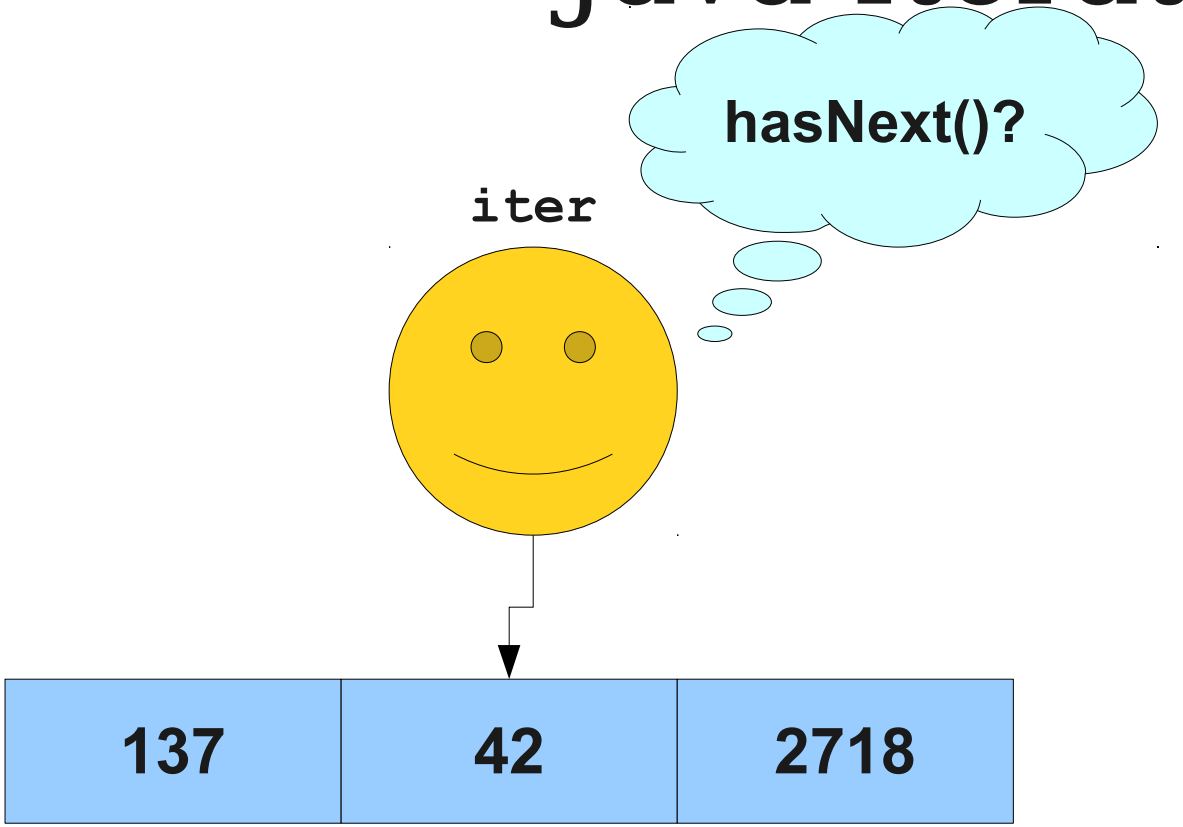


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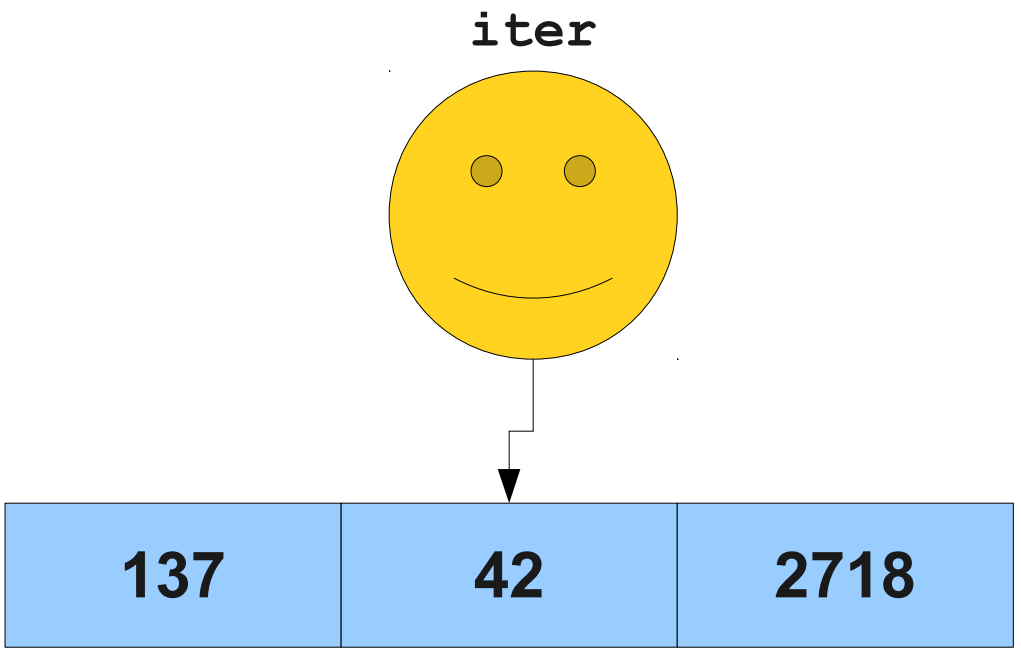


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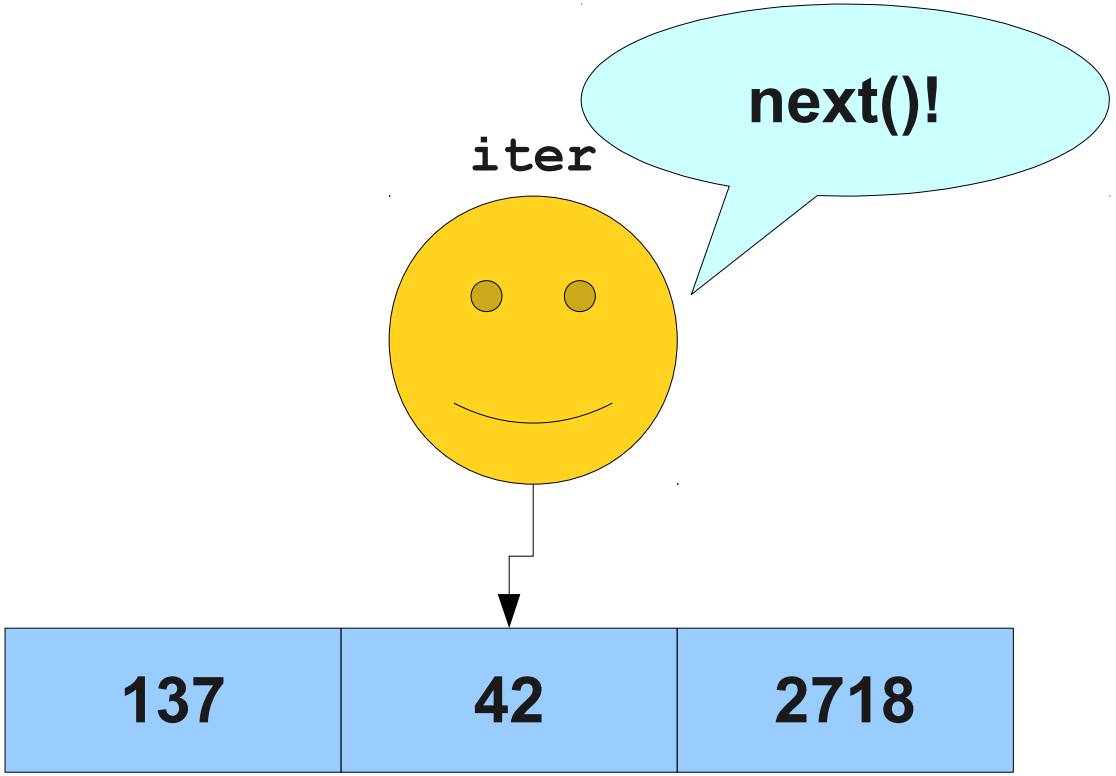


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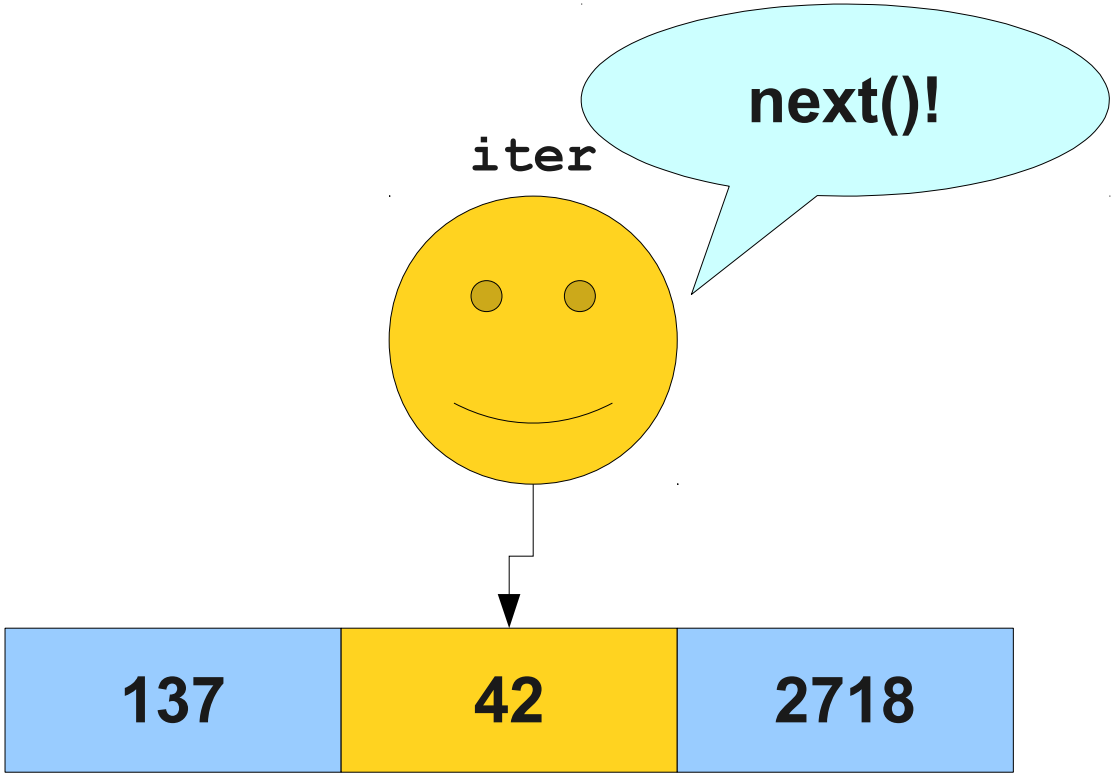


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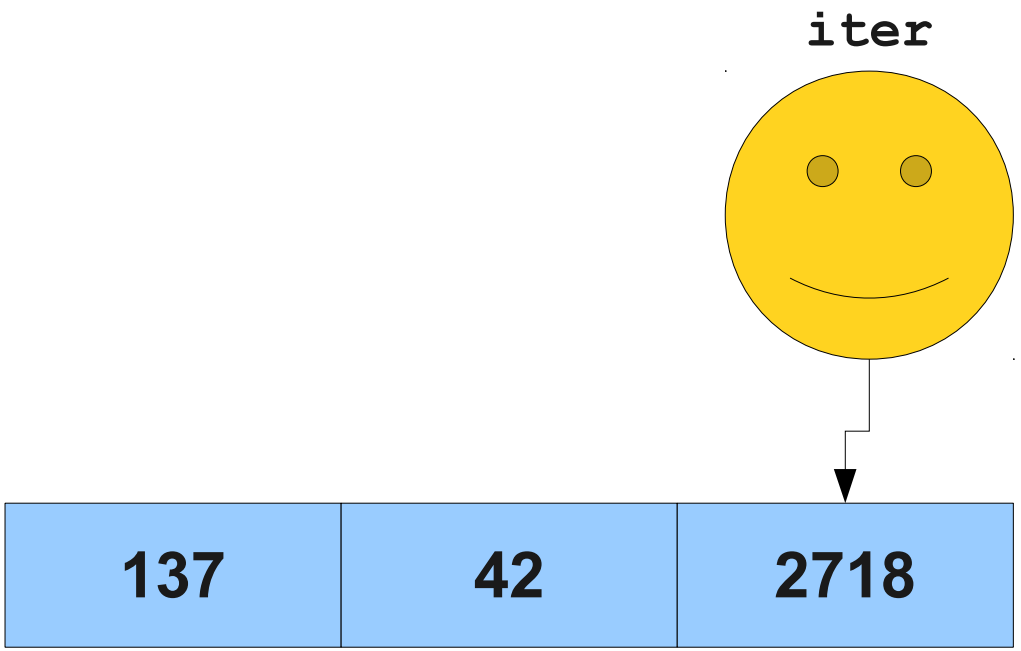


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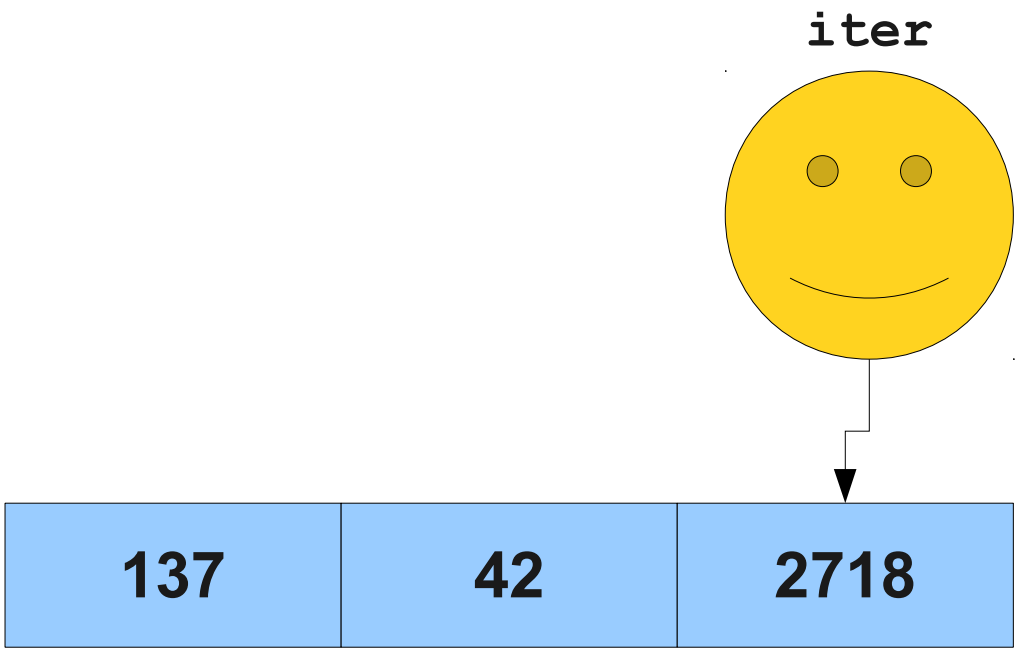


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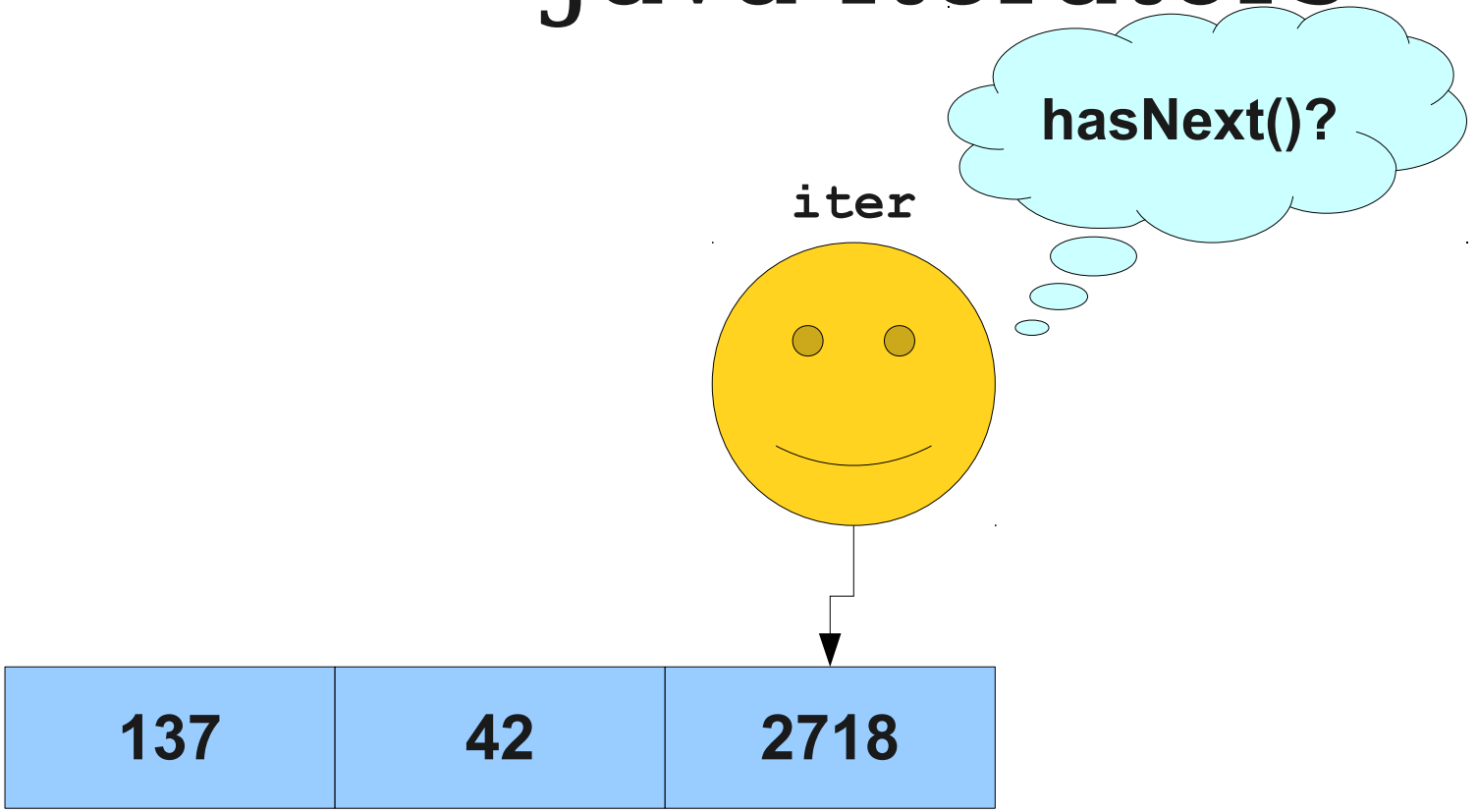


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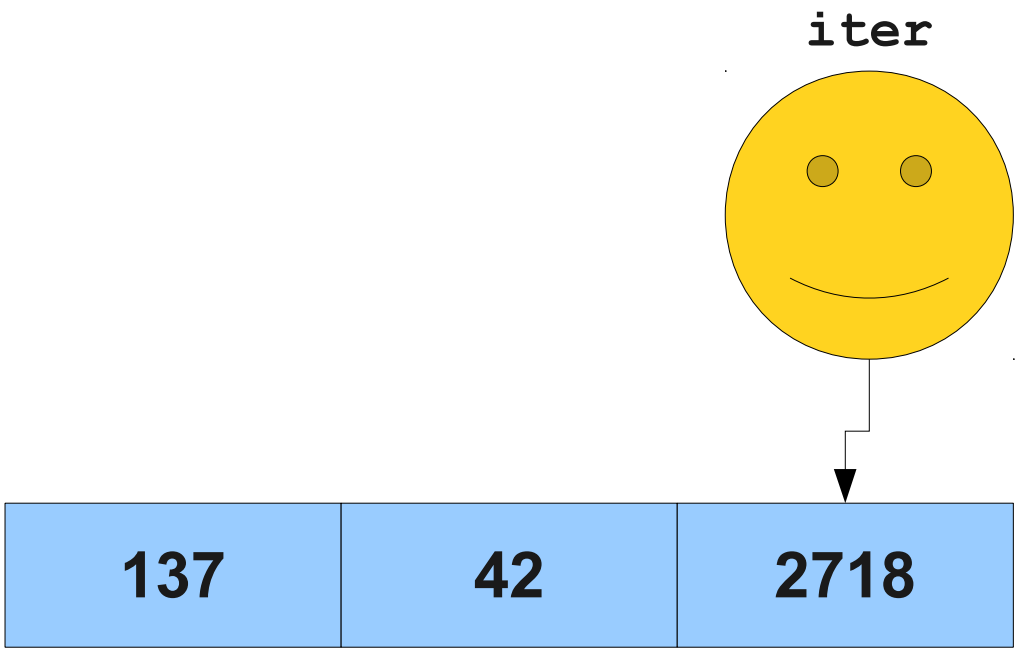


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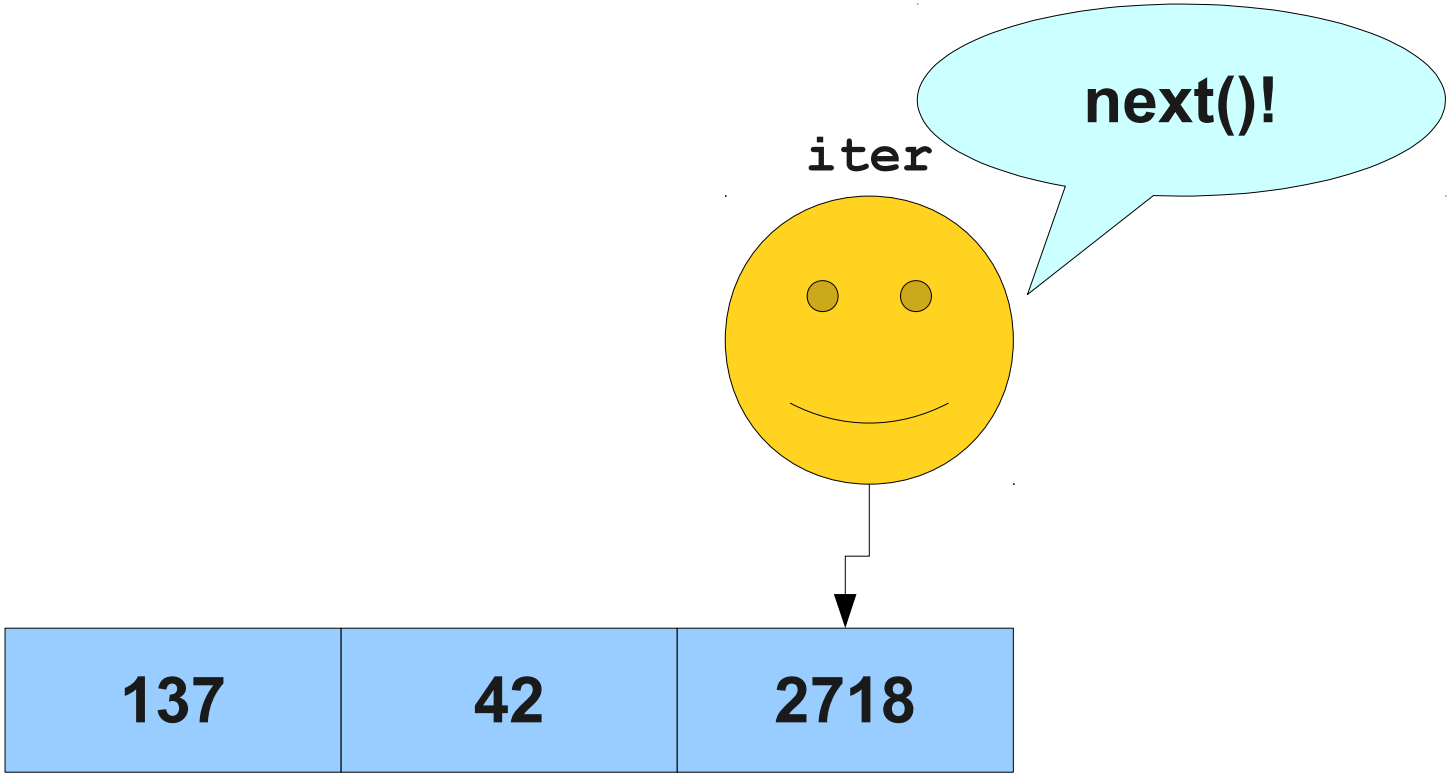


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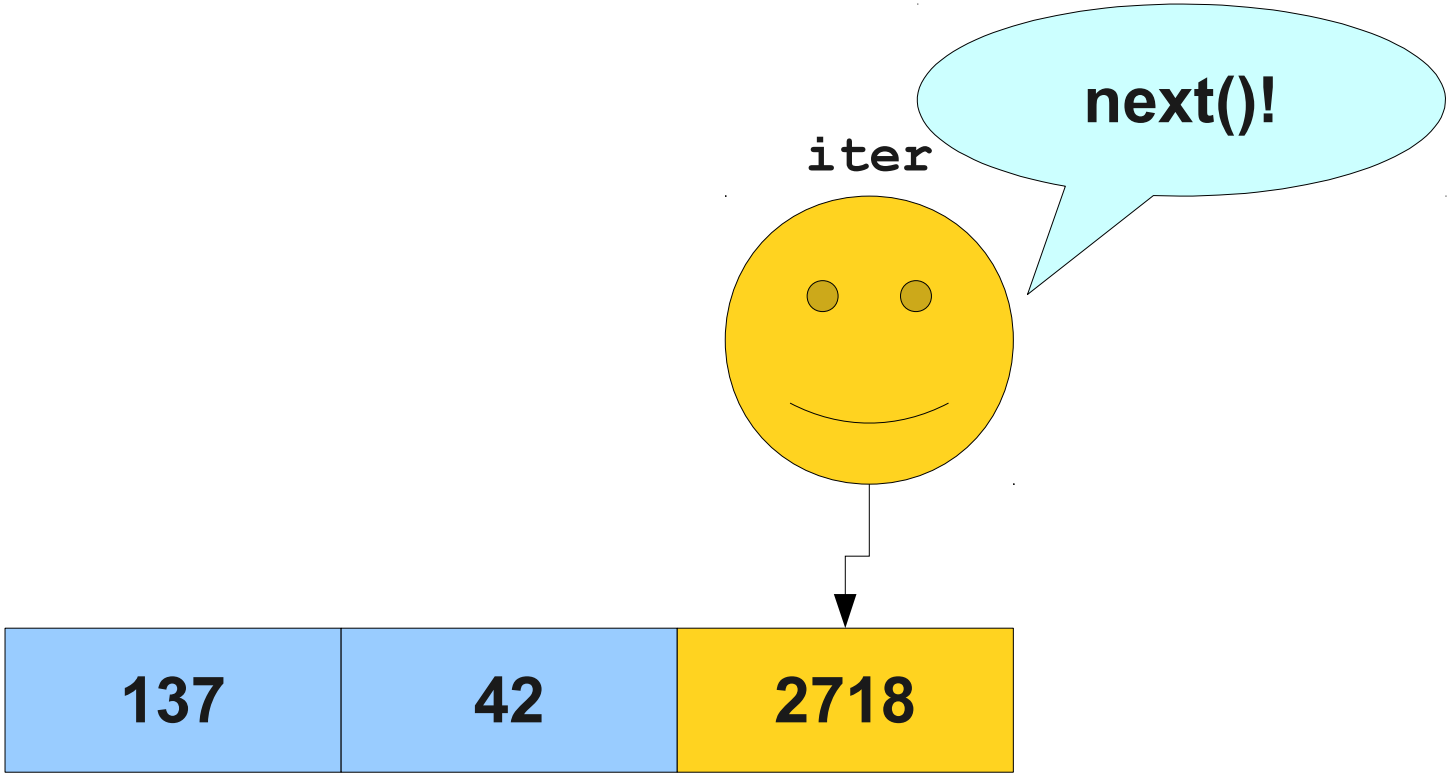


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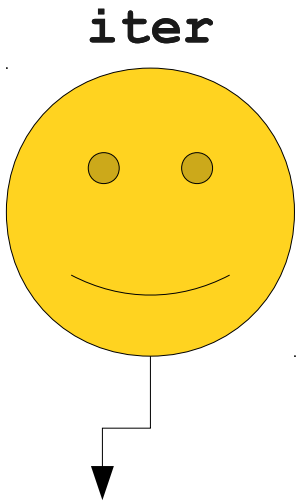

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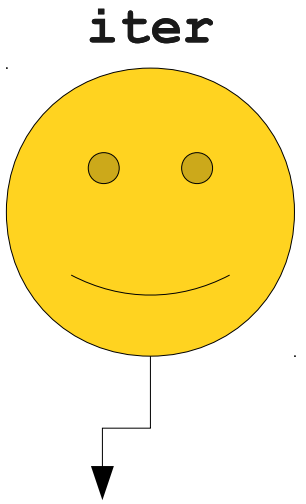

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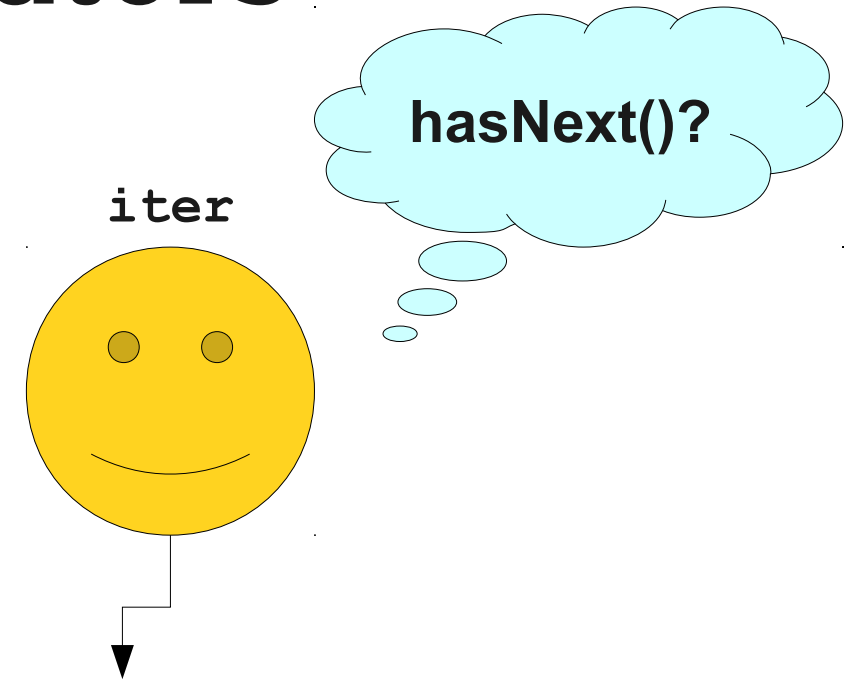

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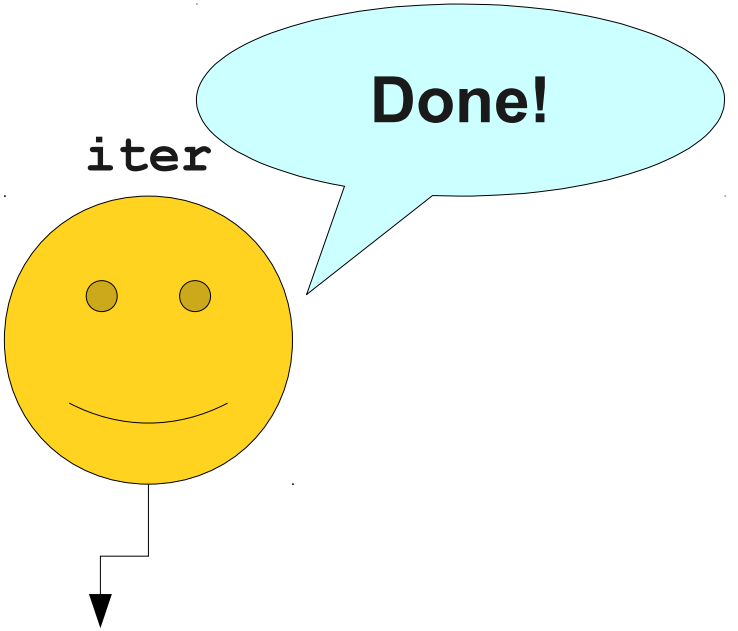

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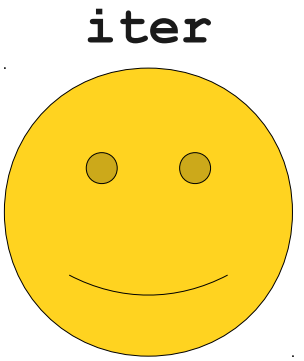
Java Iterators



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

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

    /* … use curr … */
}
```

A Use Case for Iterators

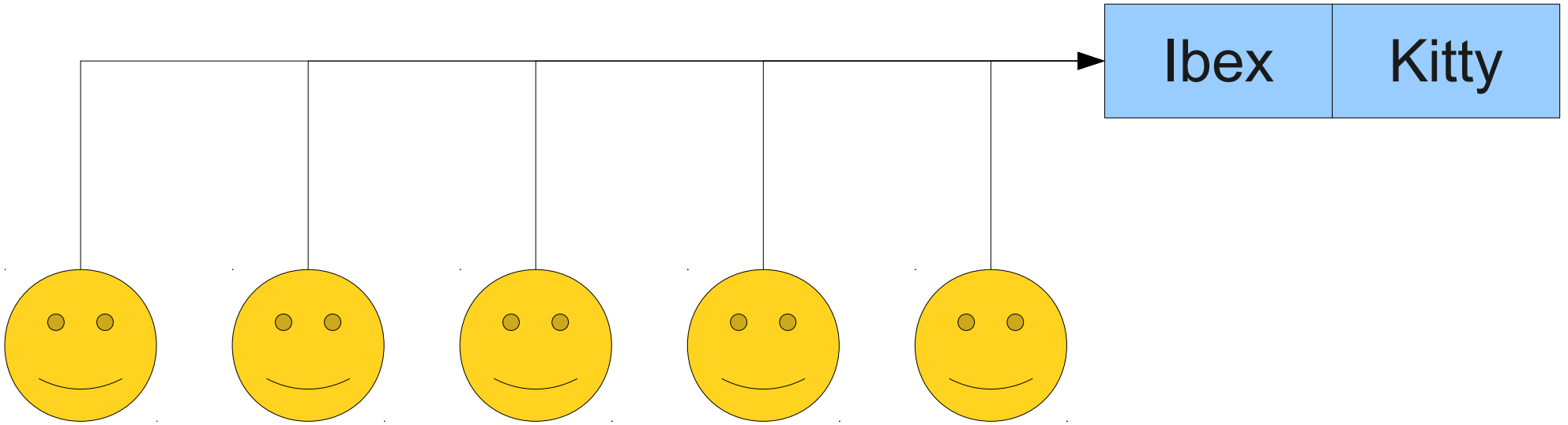
- Because all collections have iterators, a method can return an iterator to indicate “here is some data to look at.”
- Internally, that data can be stored in any format.
- Separates the **implementation** (how the class works) from the **interface** (how the class is used).

A Word of Warning

- 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.



A Word of Warning

- The follo ty collection:

```
while (c {
    /* …
}
```

- Every tim et back a new itera

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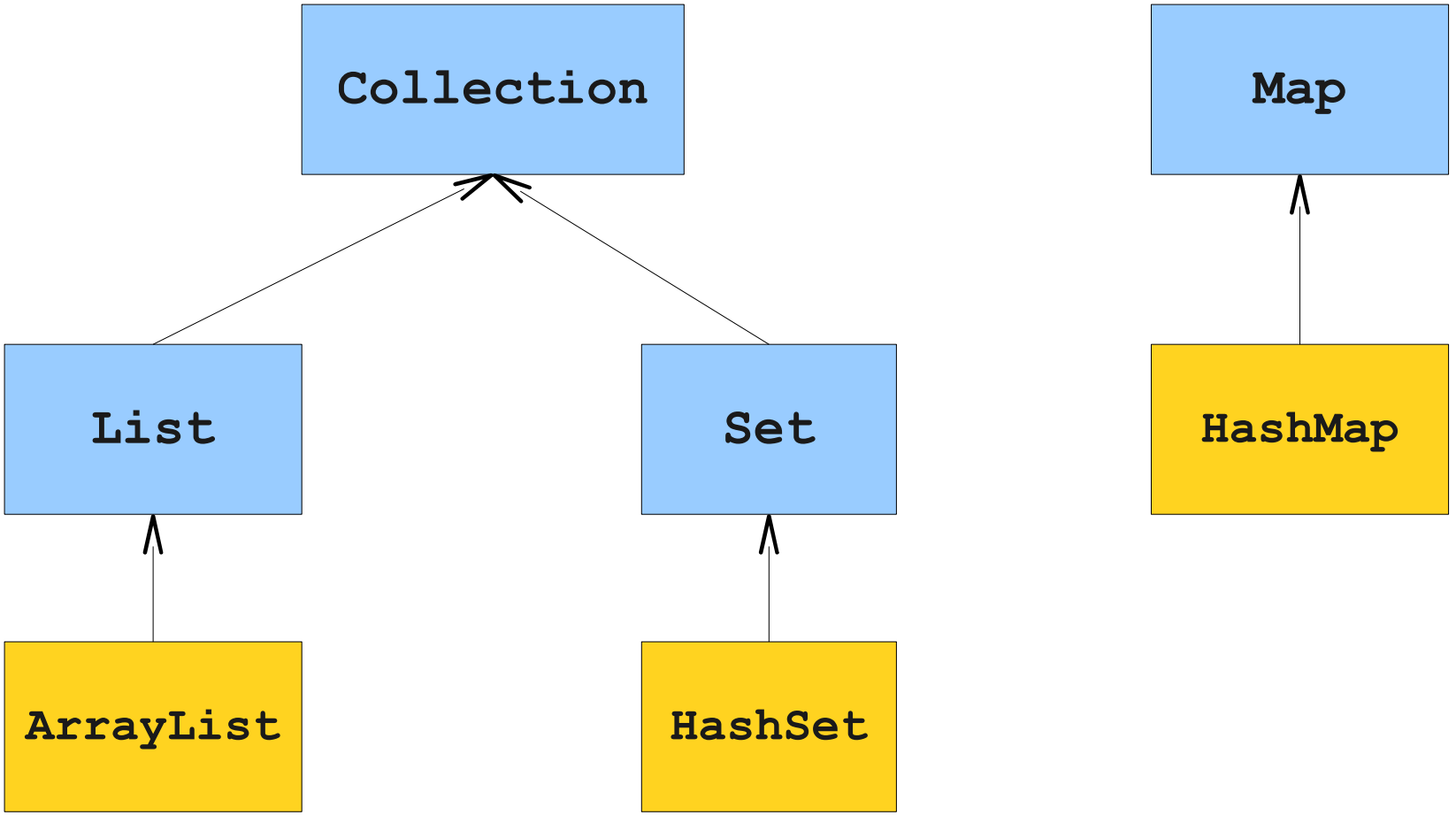
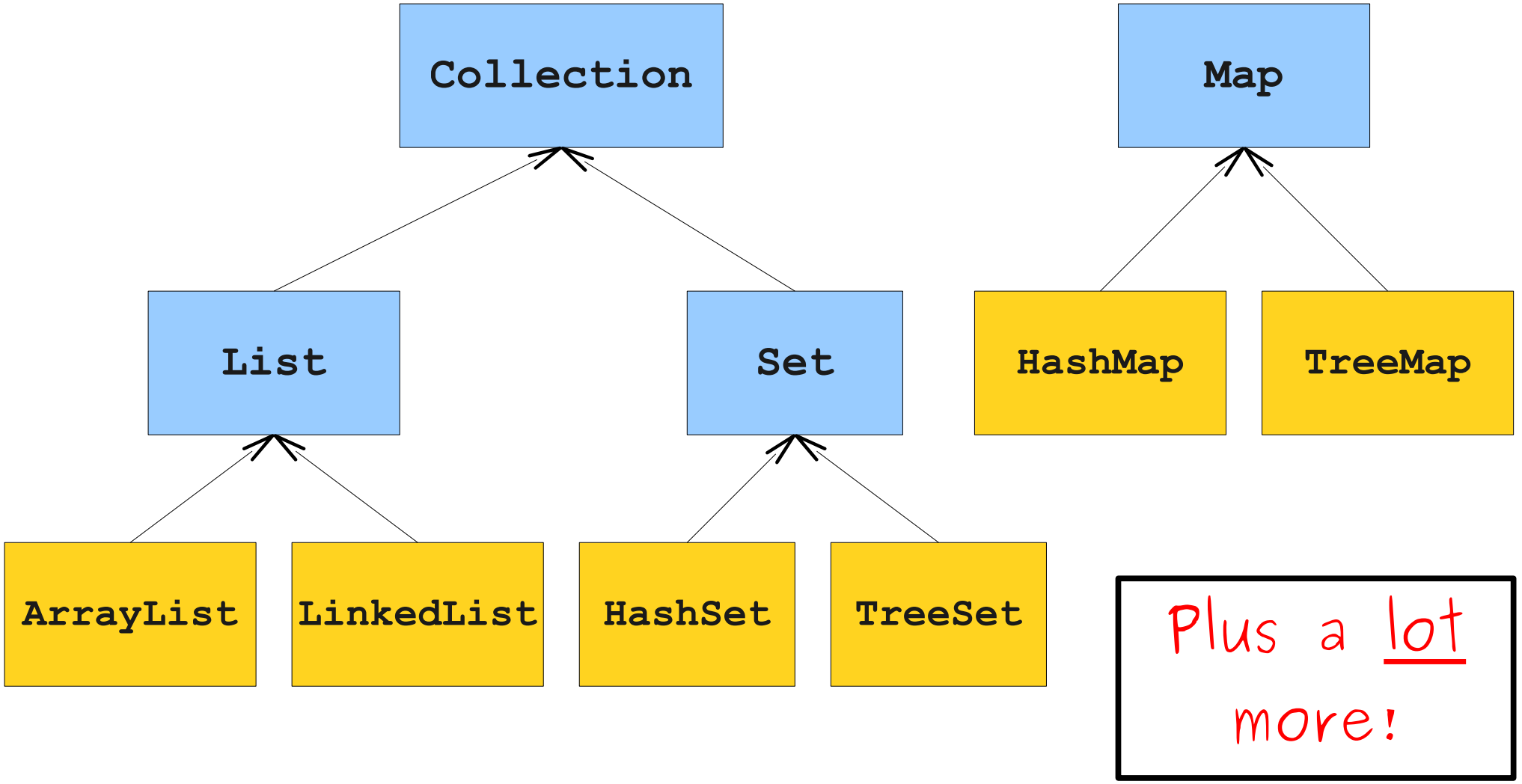
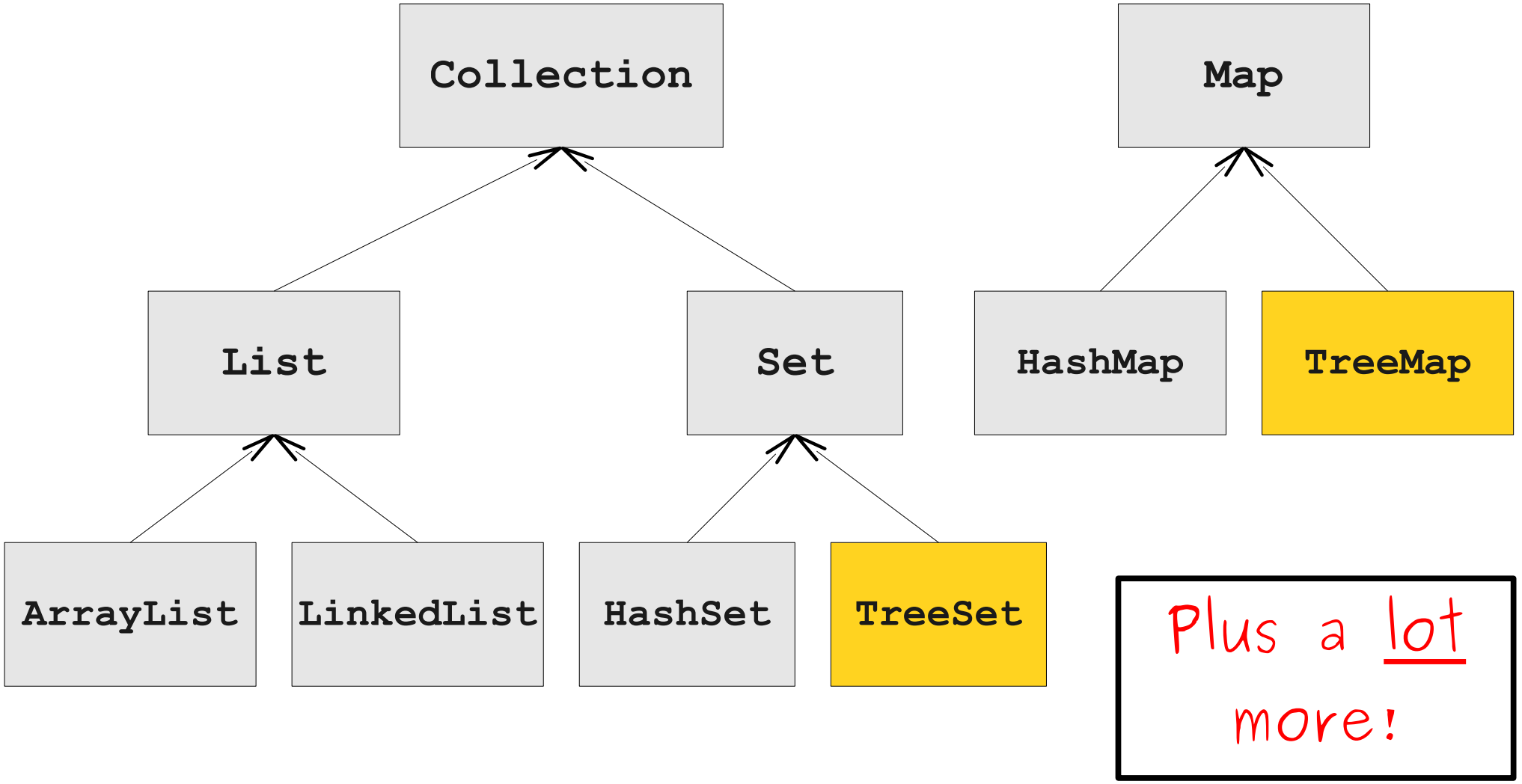
The Collections Framework



The Collections Framework



The Collections Framework



`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**.