Collections, Part Three

Announcements

- Two handouts online
  - Assignment 2: Fun with Collections
  - Section Handout

Lexicon

Lexicon

- A **Lexicon** is a container that stores a collection of words.
- No definitions are associated with the words; it is a “lexicon” rather than a “dictionary.”
- Contains operations for
  - Checking whether a word exists.
  - Checking whether a string is a prefix of a given word.

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

http://travel.paintedstork.com/blog/image/yellow_browed_bulbul.jpg

More than One Caracara

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

Introducing the Dikdik

tautonyms
(Pseudocode)

foreach

- You can loop the elements of any collection class using the **foreach** macro:

```
foreach (type var in collection) {
    /* … do something with var …
*/
}
```

- **foreach** is ***not*** a part of standard C++; it's a *macro* that we've built to keep things simple.

`tautonyms.cpp`

(On Computer)

Anagrams

- Two phrases are **anagrams** of one another if they have the same letters, but in a different order.
- Examples:
  - Stanford University → A Trusty Finned Visor
  - Keith Schwarz → Zither Whacks
  - Dawson Zhou → Whoa! Zounds!
- **Question:** Given an English word, can we find all anagrams of that word?

Anagram Clusters

- An **anagram cluster** is a set of words that are all anagrams of one another.

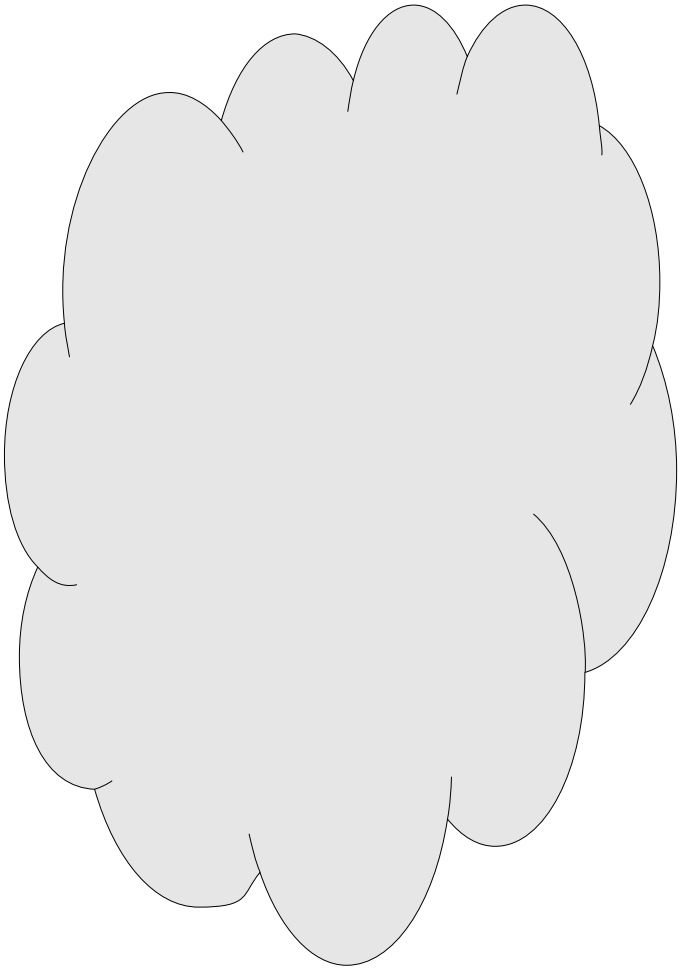
  stop ↔ tops ↔ pots ↔ spot ↔ opts ↔ post

- If we want to find all anagrams of a word, we can find its anagram cluster, then list off all the words in that cluster.
- Two questions:
  - How do we store an anagram cluster?
  - How do we find the anagram cluster associated with a given word?

Set

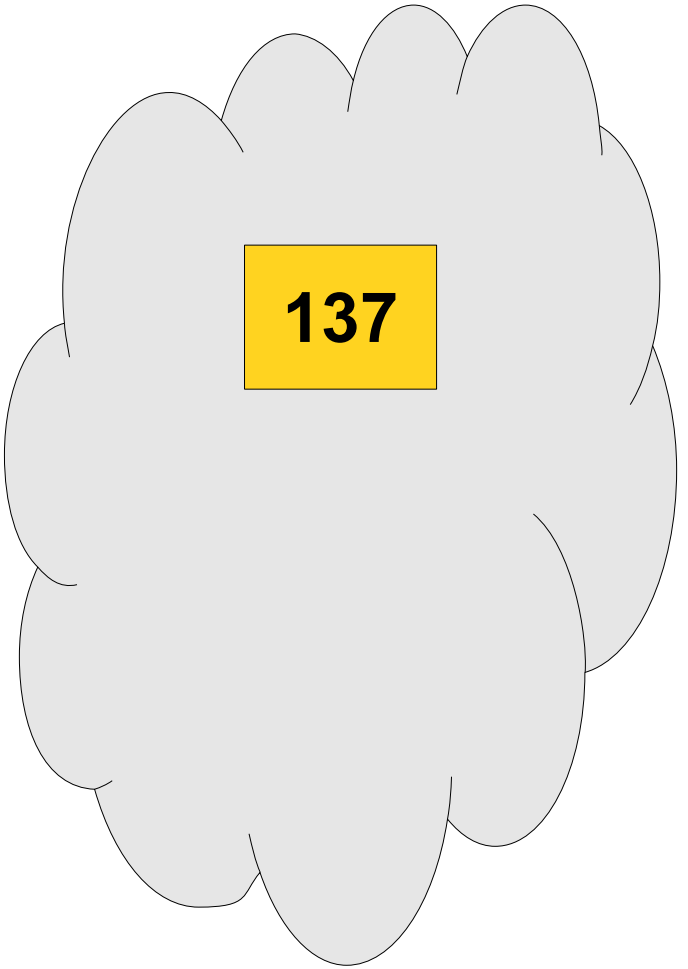
Set

- The **`Set`** represents an unordered collection of distinct elements.
- Elements can be added and removed, and you can check whether or not an element exists.



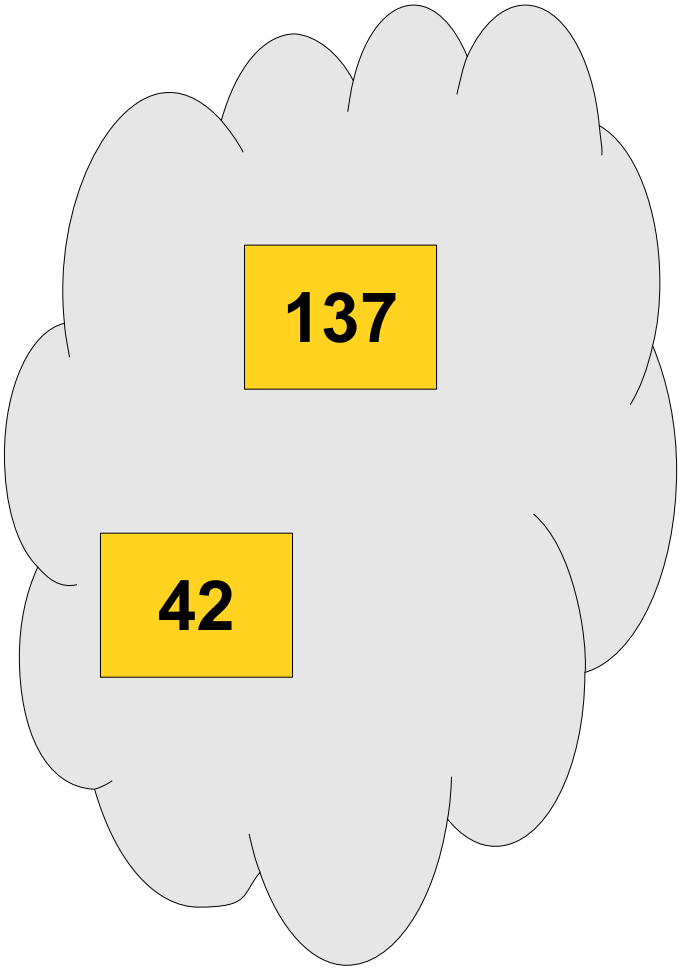
Set

- The **`Set`** represents an unordered collection of distinct elements.
- Elements can be added and removed, and you can check whether or not an element exists.



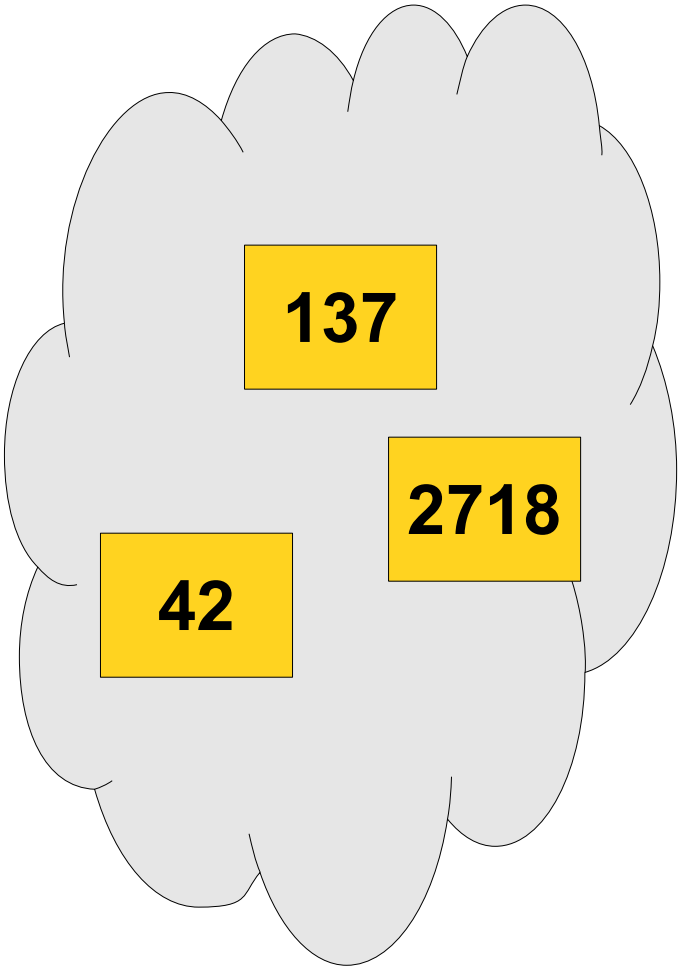
Set

- The **`Set`** represents an unordered collection of distinct elements.
- Elements can be added and removed, and you can check whether or not an element exists.



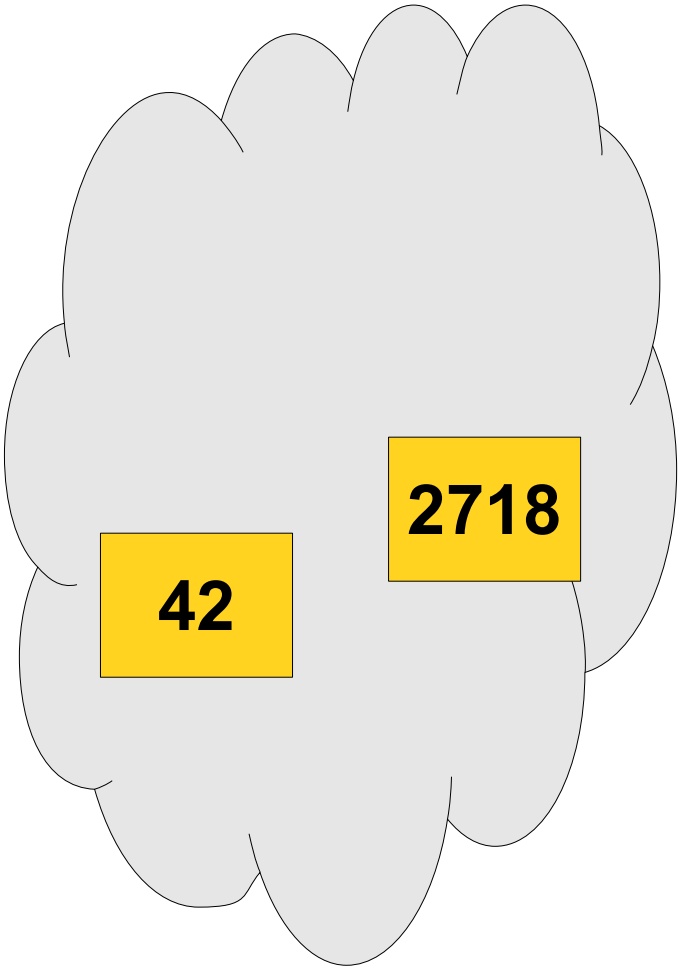
Set

- The **`Set`** represents an unordered collection of distinct elements.
- Elements can be added and removed, and you can check whether or not an element exists.



Set

- The **`Set`** represents an unordered collection of distinct elements.
- Elements can be added and removed, and you can check whether or not an element exists.



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 by writing

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

- Many more operations available (union, intersection, difference, subset, etc.), so be sure to check the documentation.

Set

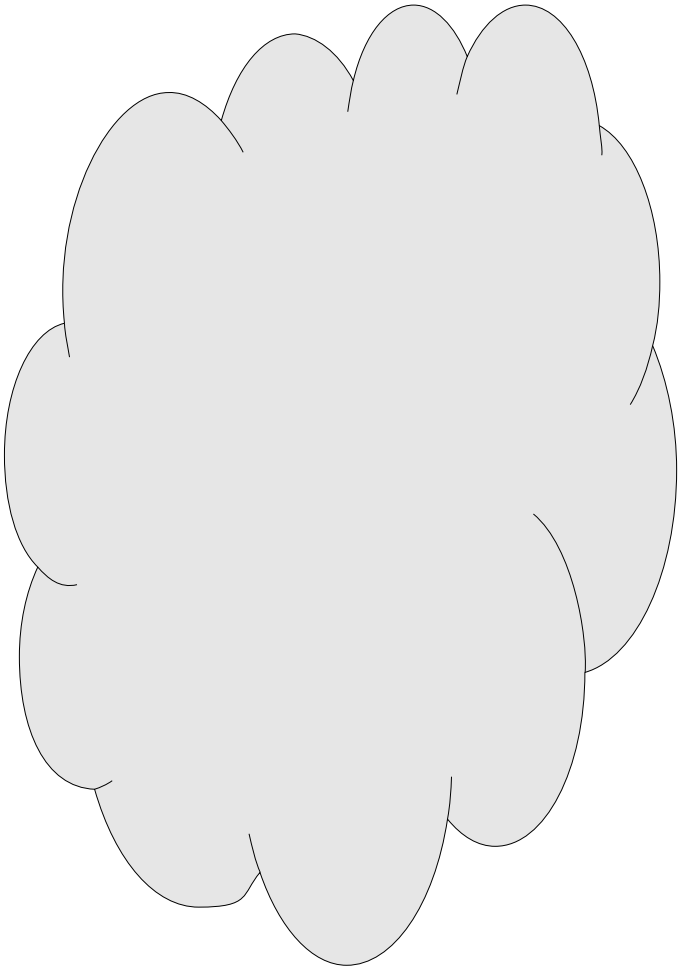
```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```

Set

```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```

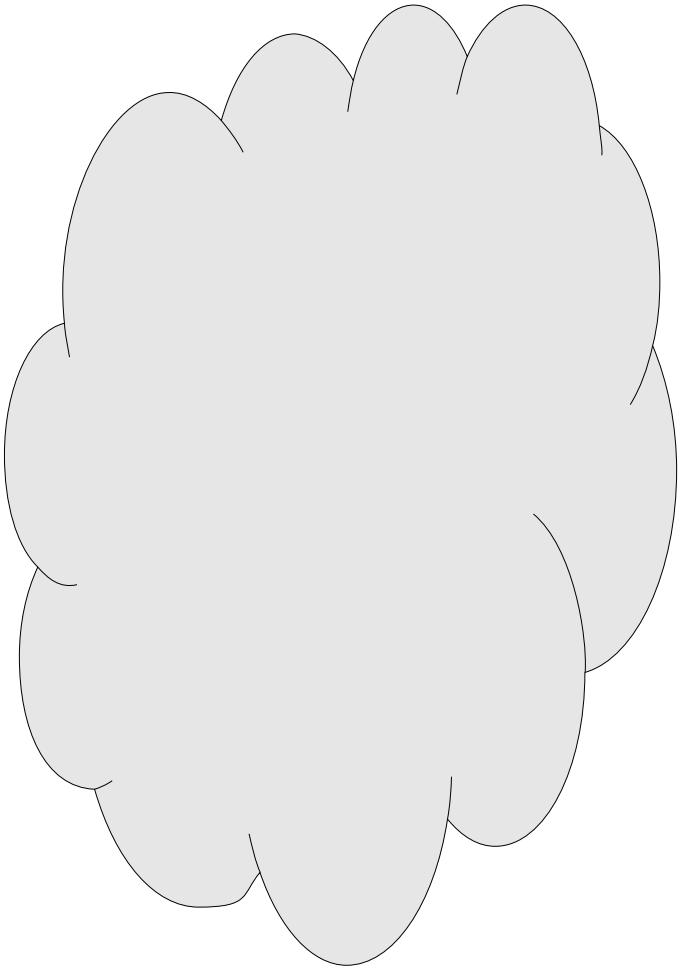
Set

```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```



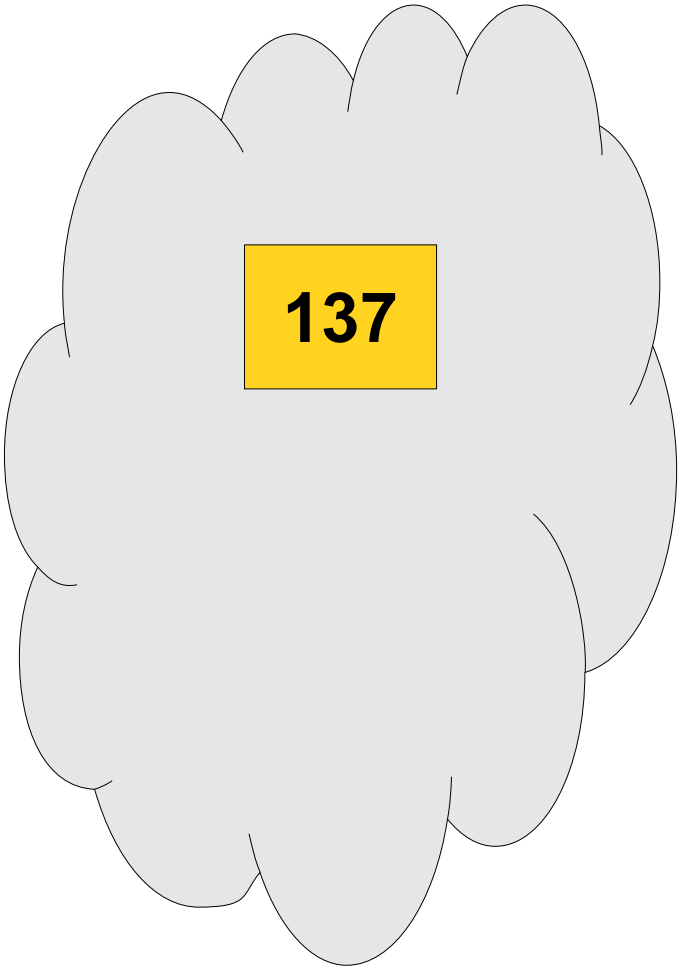
Set

```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```



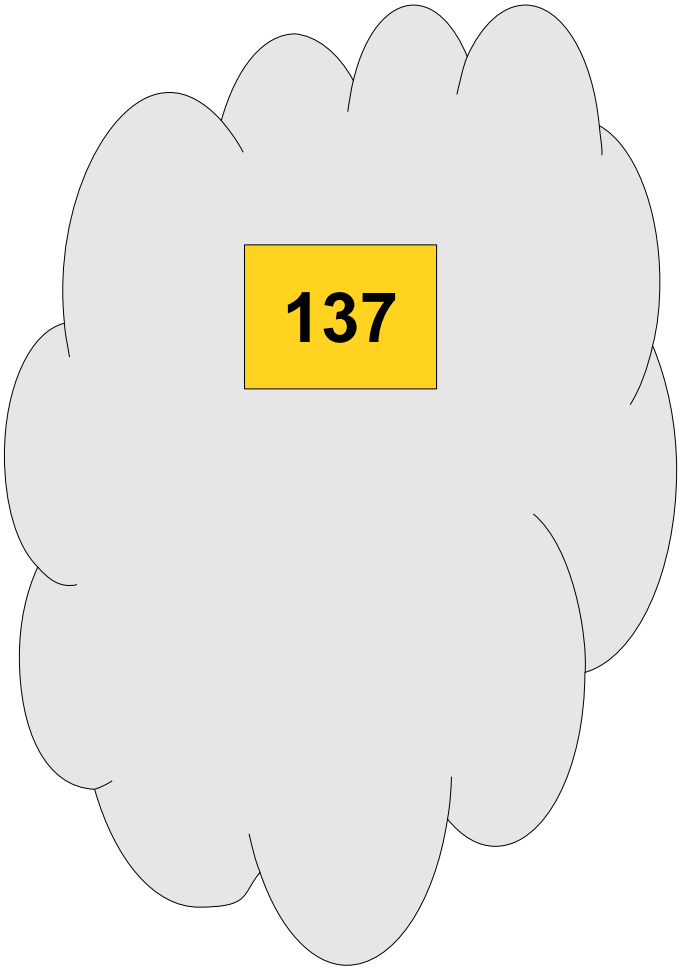
Set

```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```



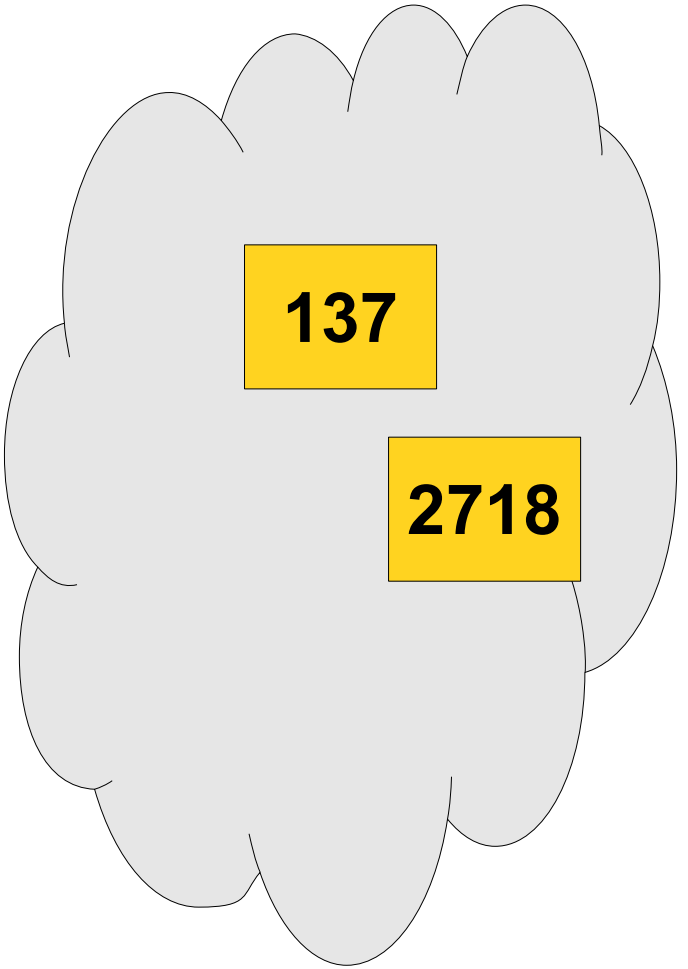
Set

```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```



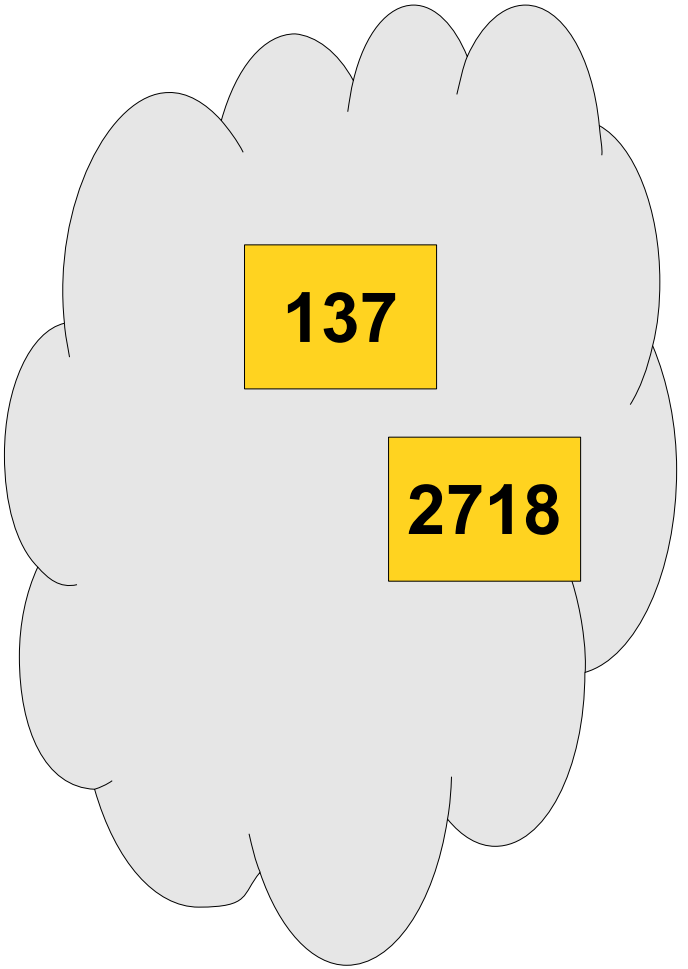
Set

```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```



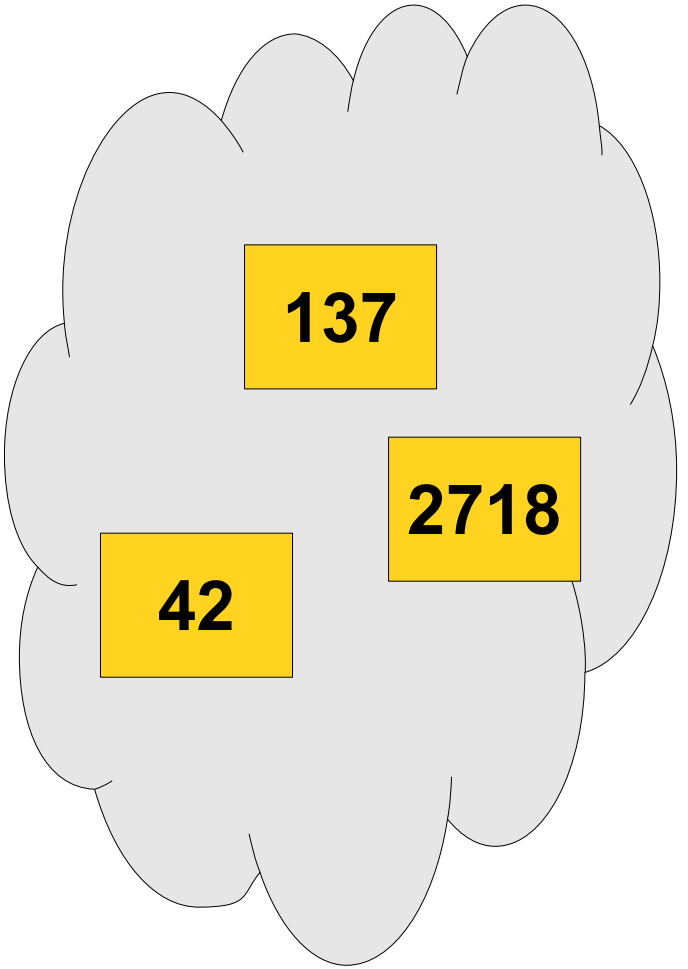
Set

```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```



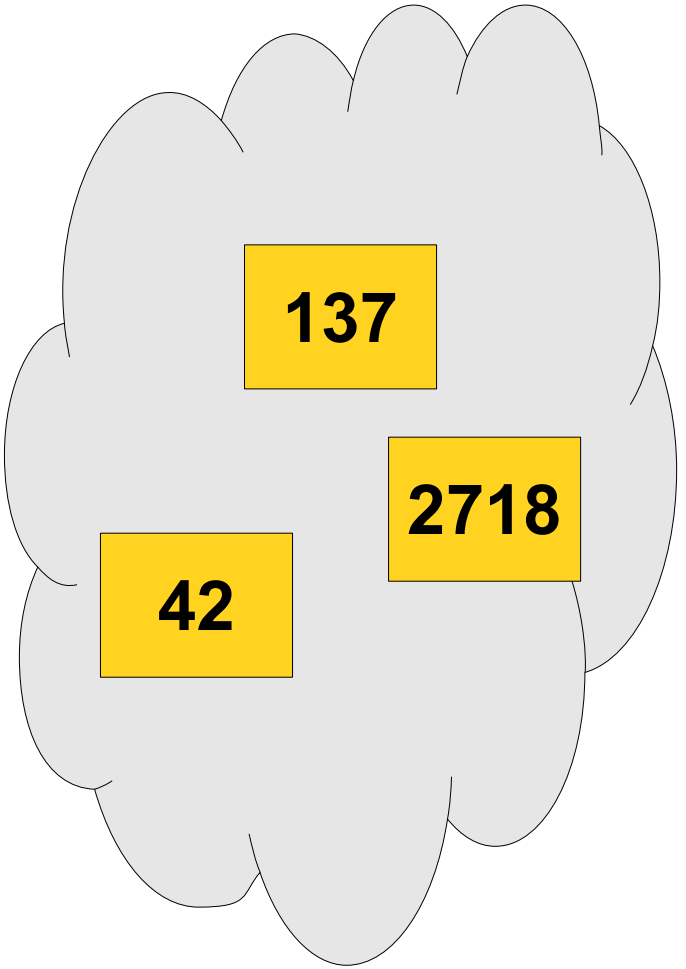
Set

```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```



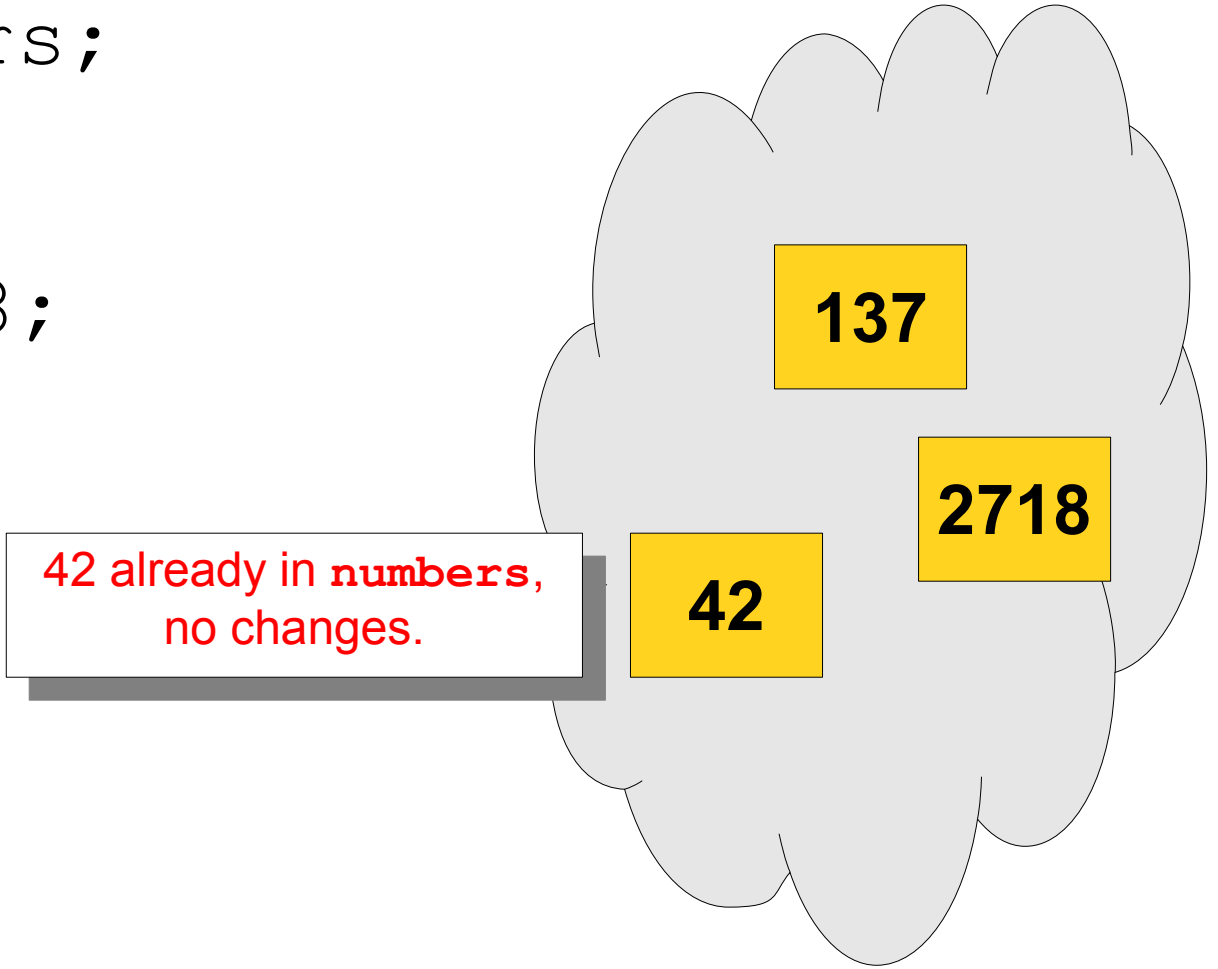
Set

```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```



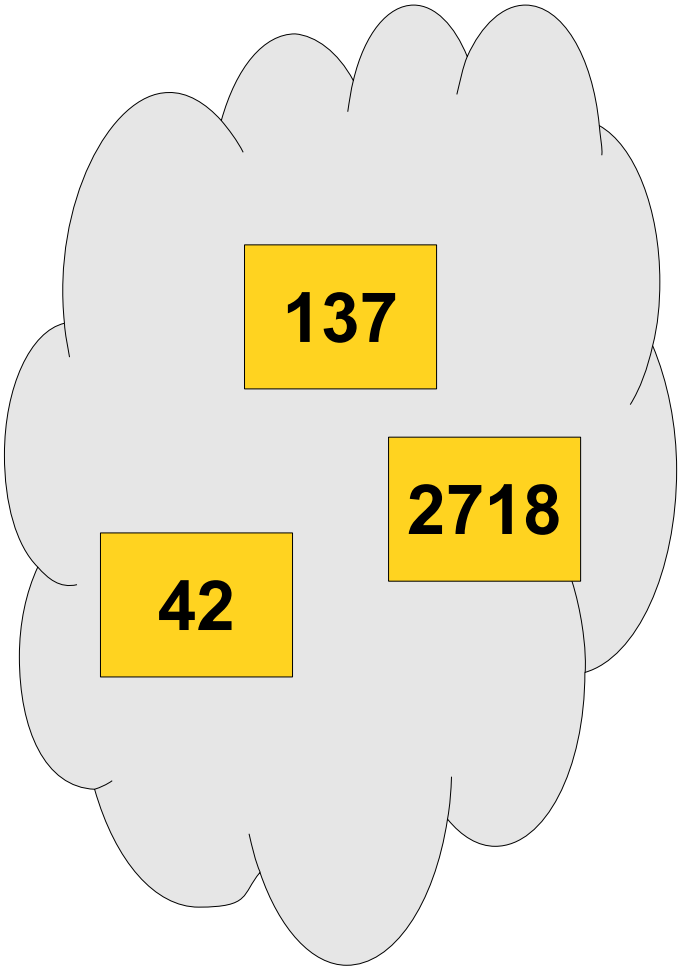
Set

```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```



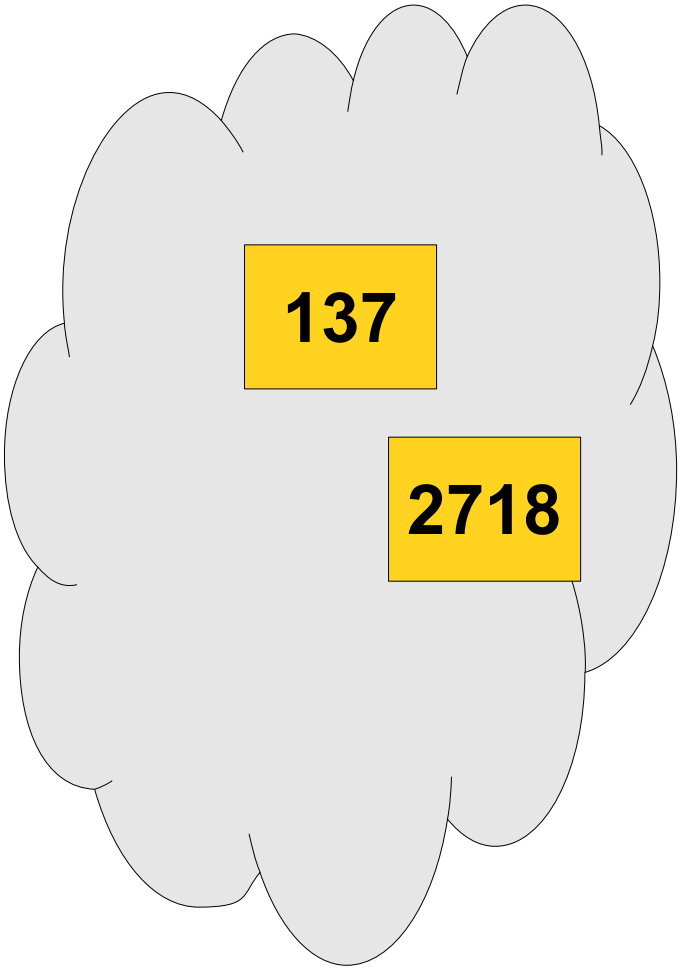
Set

```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```



Set

```
Set<int> numbers;
numbers += 137;
numbers += 2718;
numbers += 42;
numbers += 42;
numbers -= 42;
```



Anagram Clusters

- We can store each anagram cluster as a `Set<string>`.
- We still need a way of associating words to anagram clusters.

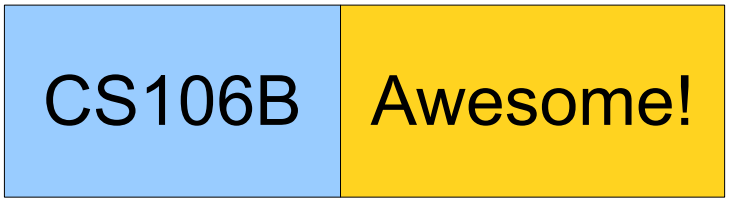
Map

Map

- The **`Map`** class represents a set of key/value pairs.
- Each key is associated with a unique value.
- Given a key, can look up the associated value.

Map

- The **`Map`** class represents a set of key/value pairs.
- Each key is associated with a unique value.
- Given a key, can look up the associated value.



Map

- The **`Map`** class represents a set of key/value pairs.
- Each key is associated with a unique value.
- Given a key, can look up the associated value.

Map

- The **`Map`** class represents a set of key/value pairs.
- Each key is associated with a unique value.
- Given a key, can look up the associated value.

CS106B	Awesome!
Dikdik	Cute!
Djikstra	Pathfinding

Using the `Map`

- You can create a map by writing

  `Map<`***KeyType***`,` ***ValueType***`>` ***map***`;`

- You can add or change a key/value pair by writing

  map`[`***key***`]` = ***value***`;`

  If the key doesn't already exist, it is added.

- You can read the value associated with a key by writing

  map`[`***key***`]`

  If the key doesn't exist, it is added and associated with a default value.

- You can check whether a key exists by calling

  map`.containsKey(`***key***`)`

Anagram Clusters

- We can use `Map<string,Set<string> >` to match strings to anagram clusters
  - Key: Some sort of unique identifier for each anagram cluster
  - Value: Set of words in the anagram cluster
- What should we use for the key? How can we uniquely identify an anagram cluster?

Sorting Letters

- One way to check whether two words are anagrams of one another is to reorder the letters into ascending order:

bleat → abelt

table → abelt

Sorting Letters

- One way to check whether two words are anagrams of one another is to reorder the letters into ascending order:

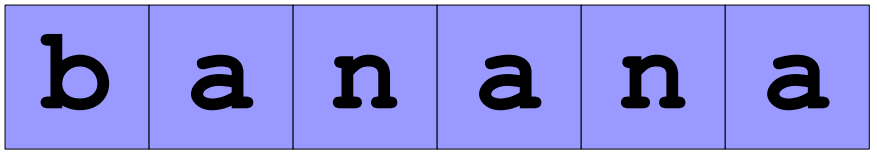
  bleat → abelt

  table → abelt

- **Idea**: Build a `Map<string, Set<string> >` to represent anagram clusters.
  - Each key is the letters of a word in sorted order.
  - Each value is the set of all words with those letters.

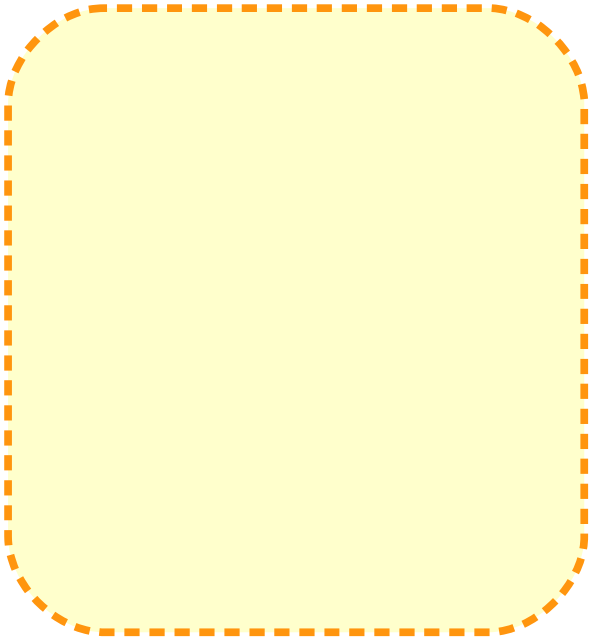
Counting Sort

Counting Sort



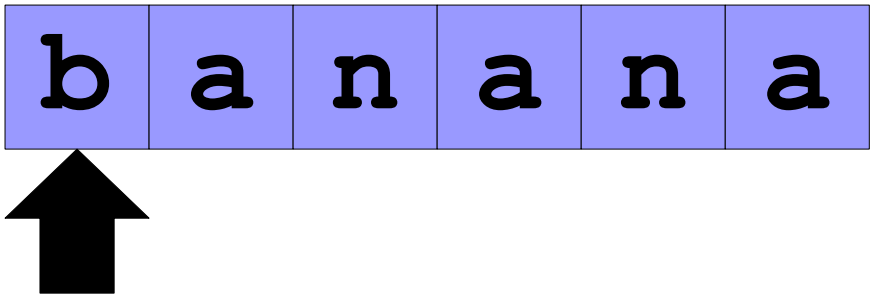
Counting Sort

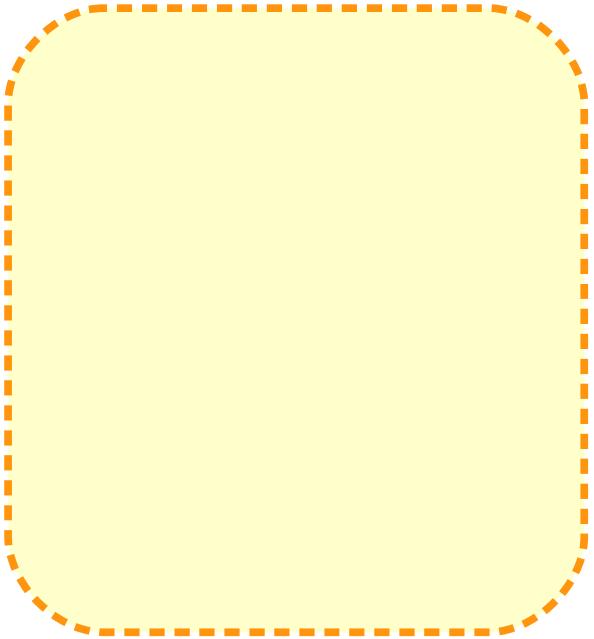
b	a	n	a	n	a



`Map<char, int>`

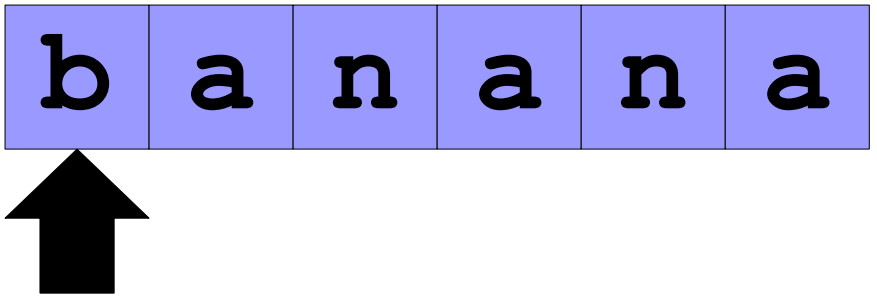
Counting Sort

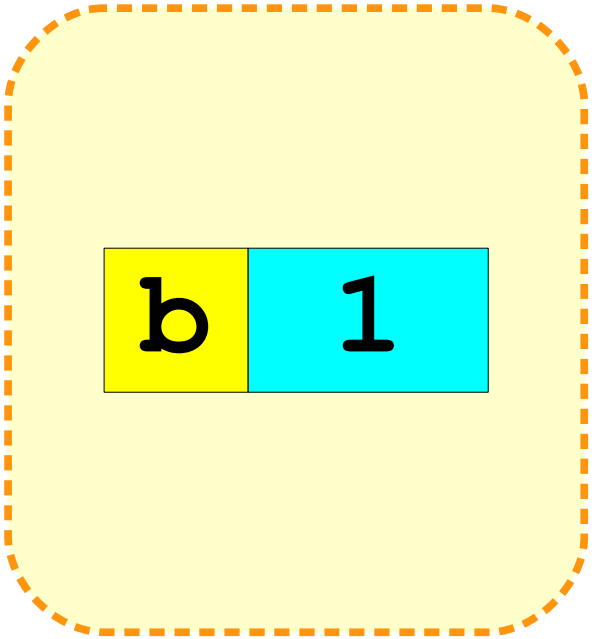




`Map<char, int>`

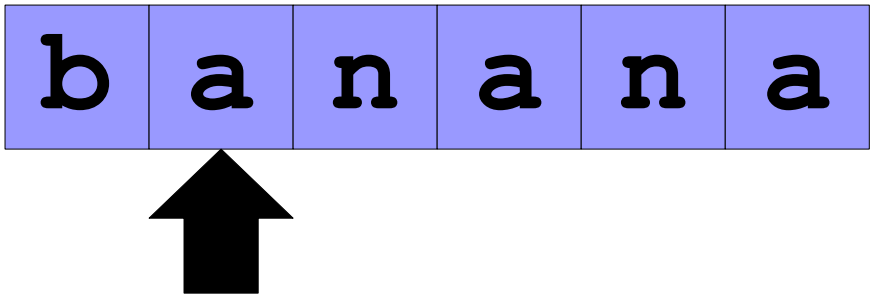
Counting Sort

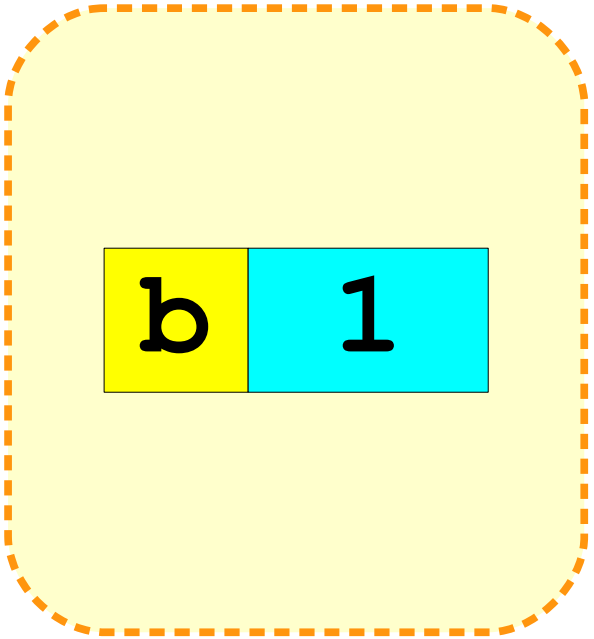




`Map<char, int>`

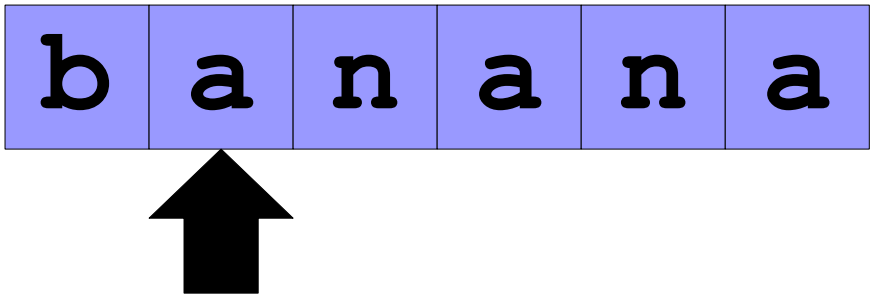
Counting Sort

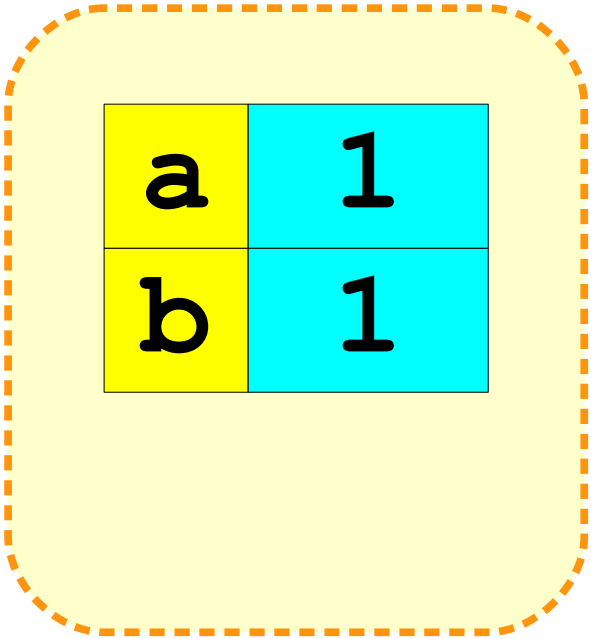




`Map<char, int>`

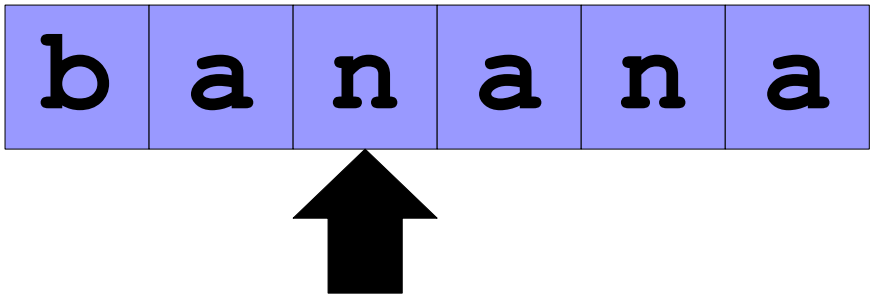
Counting Sort

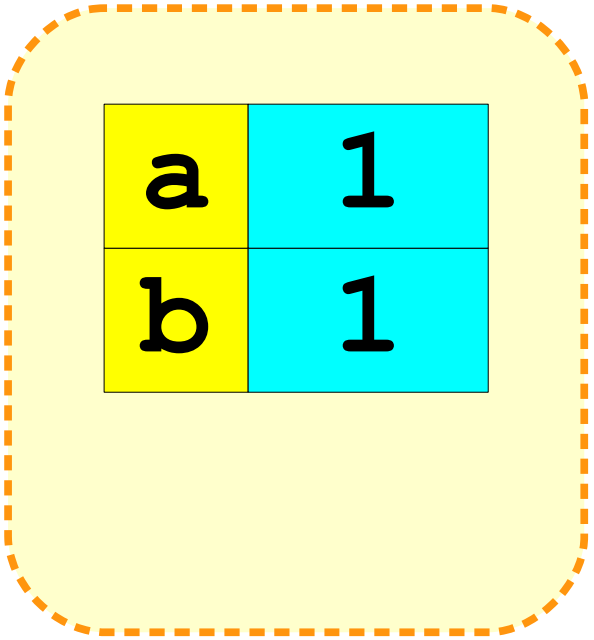




`Map<char, int>`

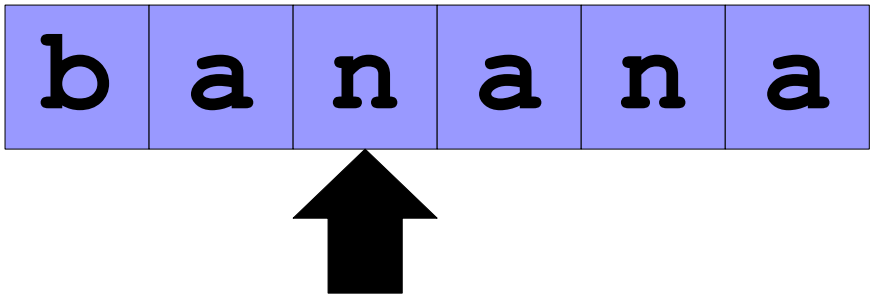
Counting Sort





`Map<char, int>`

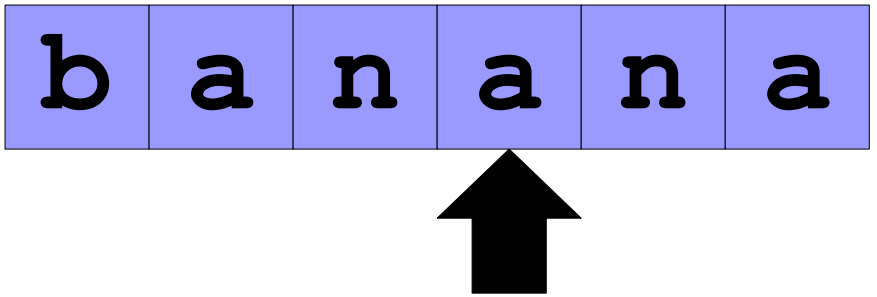
Counting Sort



a	1
b	1
n	1

`Map<char, int>`

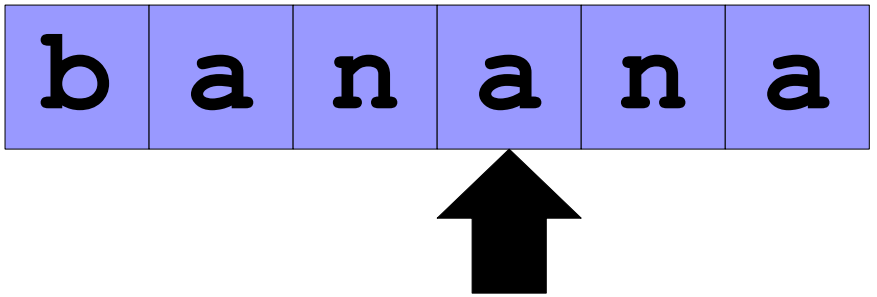
Counting Sort



a	1
b	1
n	1

`Map<char, int>`

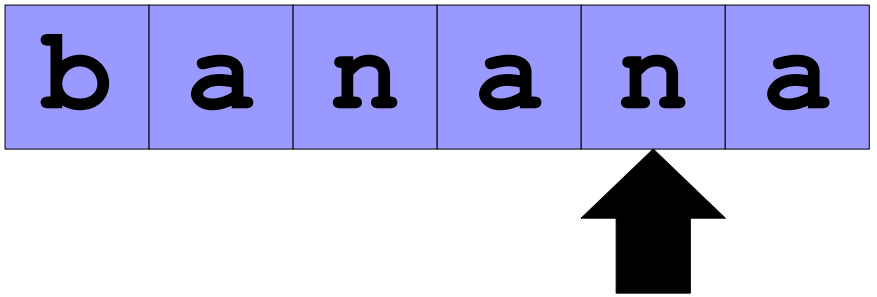
Counting Sort



a	2
b	1
n	1

`Map<char, int>`

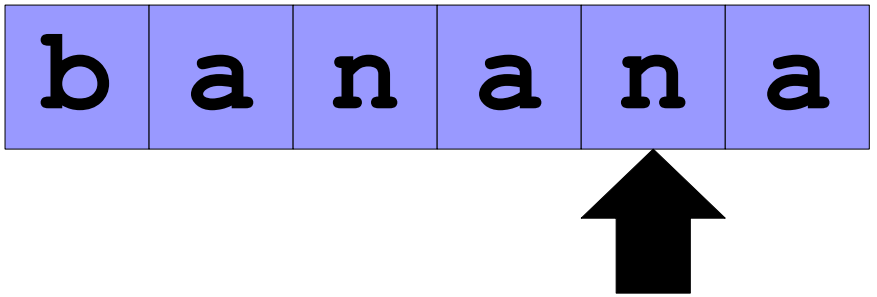
Counting Sort



a	2
b	1
n	1

`Map<char, int>`

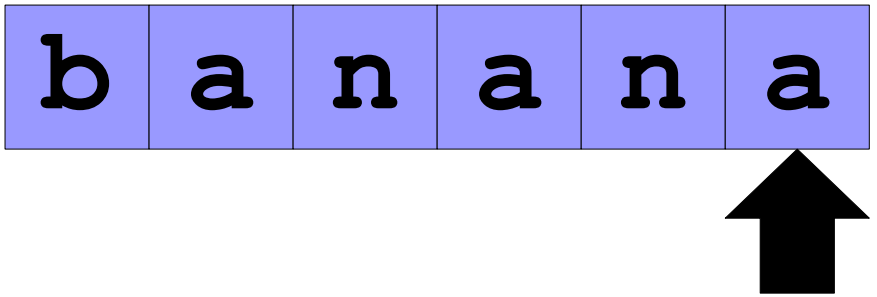
Counting Sort



a	2
b	1
n	2

`Map<char, int>`

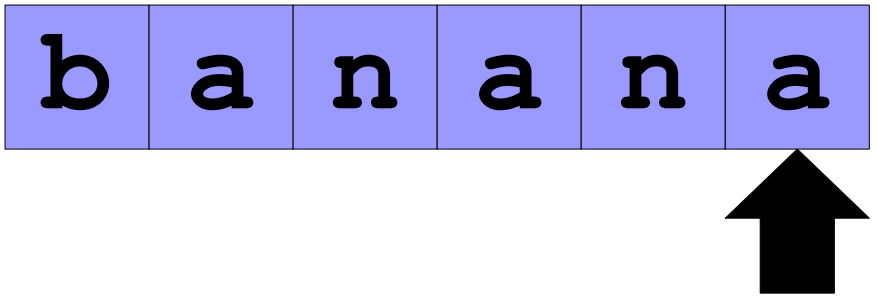
Counting Sort



a	2
b	1
n	2

`Map<char, int>`

Counting Sort



a	3
b	1
n	2

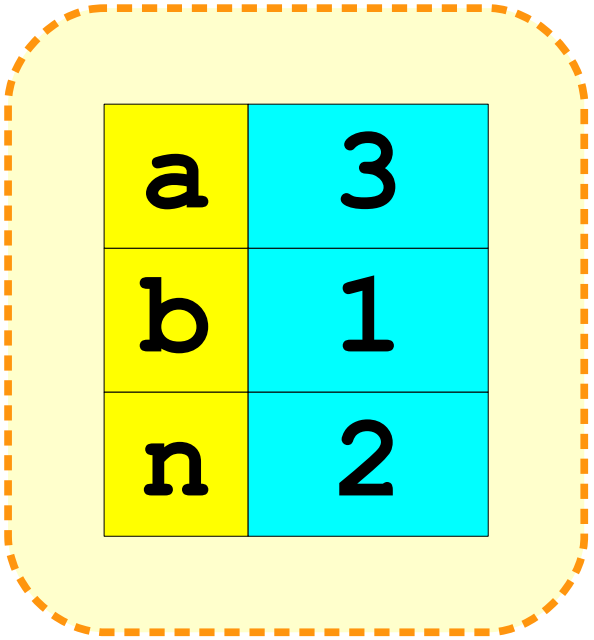
`Map<char, int>`

Ordering in `foreach`

- When using **`foreach`** to iterate over a collection:
  - In a **`Vector`**, **`string`**, or array, the elements are retrieved in order.
  - In a **`Map`**, the *keys* are returned in sorted order.
  - In a **`Set`** or **`Lexicon`**, the values are returned in sorted order.
  - In a **`Grid`**, the elements of the first row are returned in order, then the second row, etc. (this is called *row-major order*).

Counting Sort

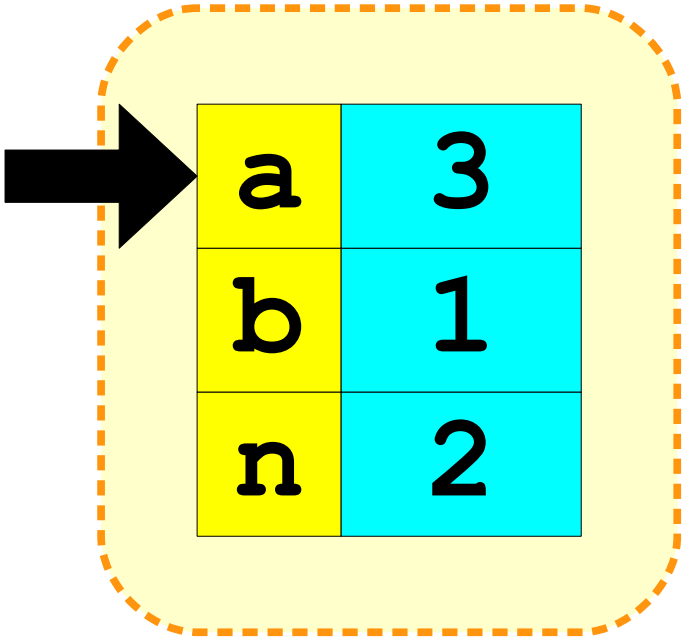
b	a	n	a	n	a



`Map<char, int>`

Counting Sort

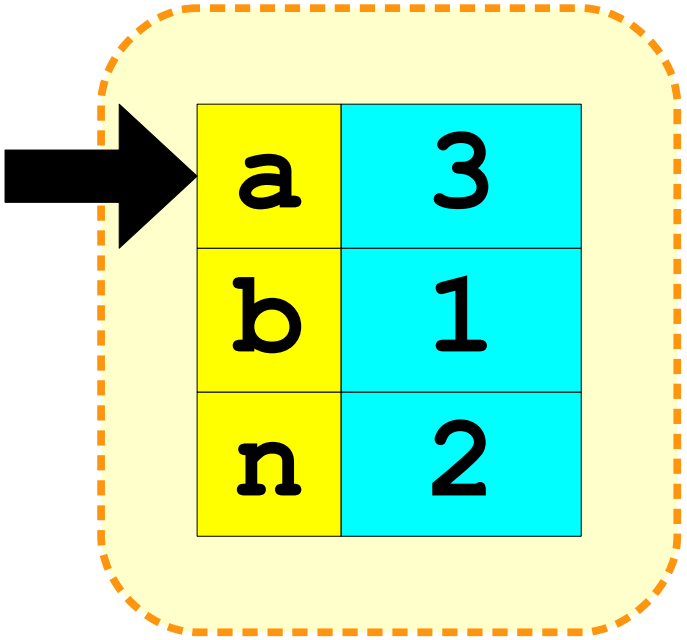
b	a	n	a	n	a



`Map<char, int>`

Counting Sort

b	a	n	a	n	a

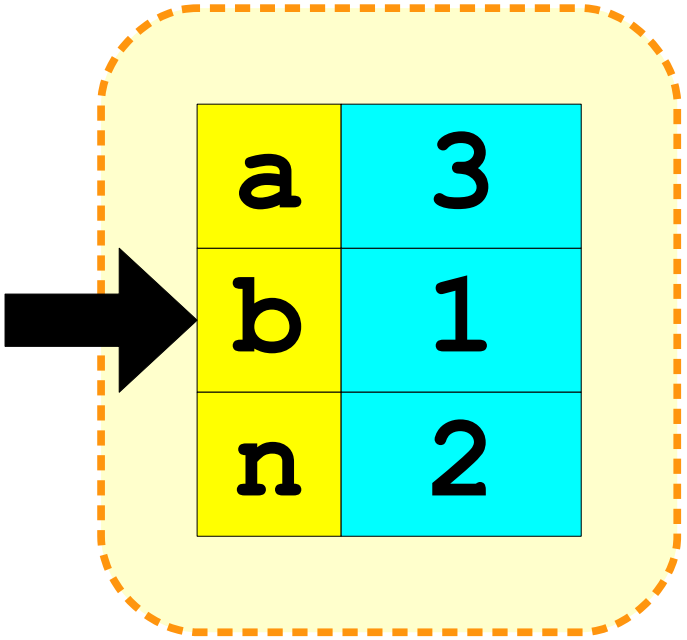


Map<char, int>

a	a	a

Counting Sort

b	a	n	a	n	a

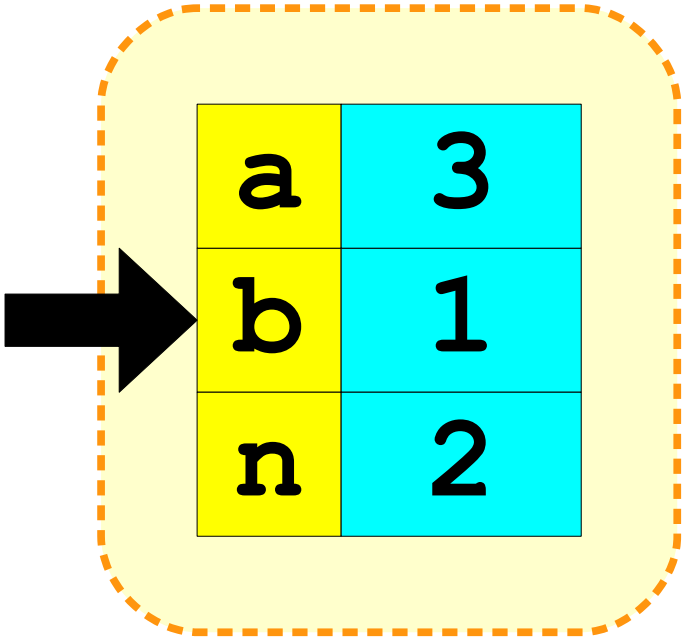


Map<char, int>

a	a	a

Counting Sort

b	a	n	a	n	a

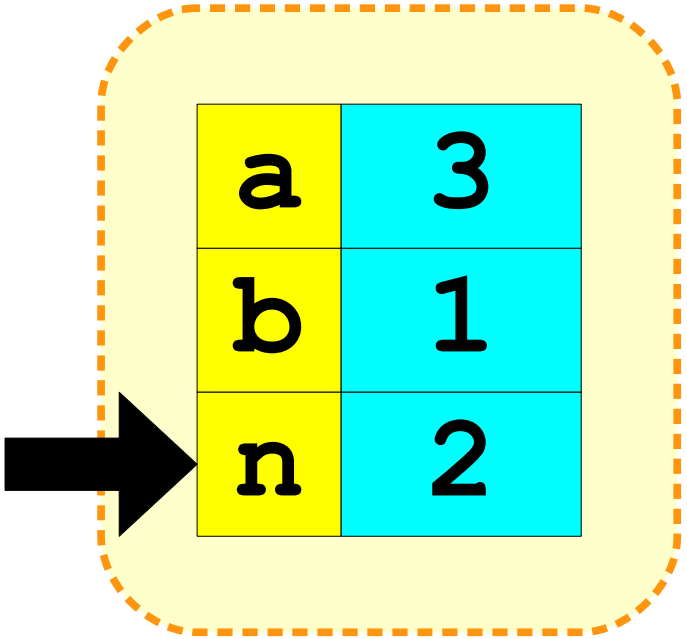


Map<char, int>

a	a	a	b

Counting Sort

b	a	n	a	n	a

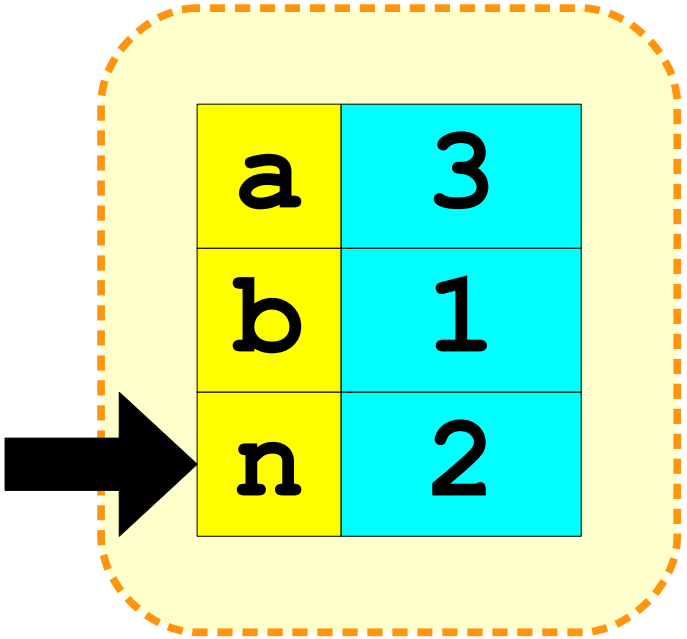


Map<char, int>

a	a	a	b

Counting Sort

b	a	n	a	n	a



Map<char, int>

a	a	a	b	n	n

Counting Sort

b	a	n	a	n	a

a	3
b	1
n	2

`Map<char, int>`

a	a	a	b	n	n

`sort()`
`anagram-clusters.cpp`
(On Computer)

anagram-clusters
(Pseudocode)

anagram-clusters.cpp
(Computer)

foreach

- Friends don't let friends modify a collection when using `foreach` to iterate over it's elements
  - Will cause your program to crash.

```
Set<int> s;
s += 1; s += 2;
foreach (int i in s) {
  s.remove(i); //ERROR!!!
}
```

`Lexicon` or `Set<string>`?

- Both the `Lexicon` and `Set<string>` can be used to represent a collection of strings. So which should you use?
- It turns out that the `Lexicon` is better for storing very large collections of strings that *don't change over time*
  - Like words in a language
- `Set<string>` are much more general purpose.
  - We'll find out why in a couple weeks!

Next Time

- **`Queue`**
  - A data structure for waiting lines.
- **Password Security**
  - How do you properly store passwords?
  - And what on earth is a hash code?