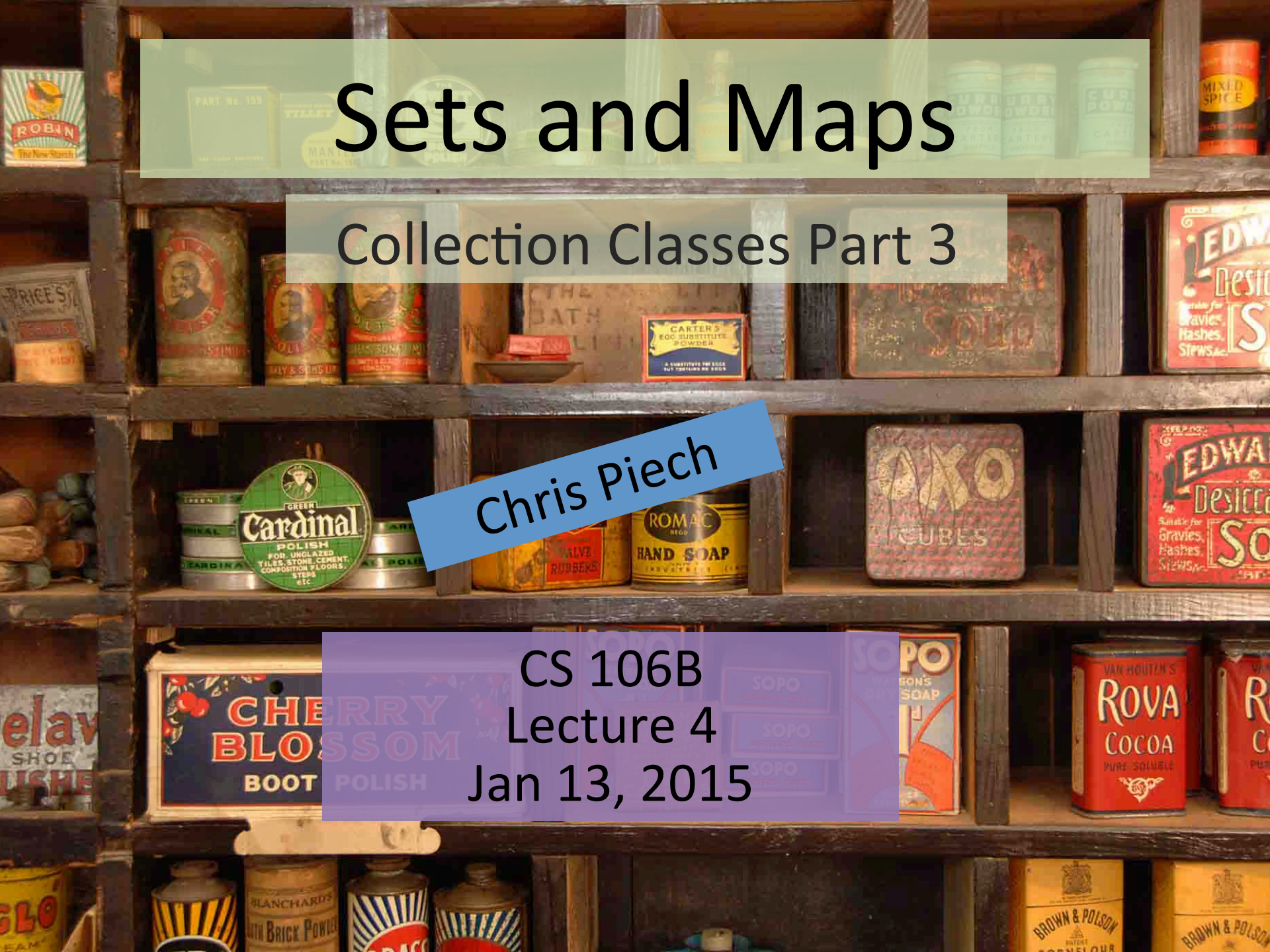
Sets and Maps

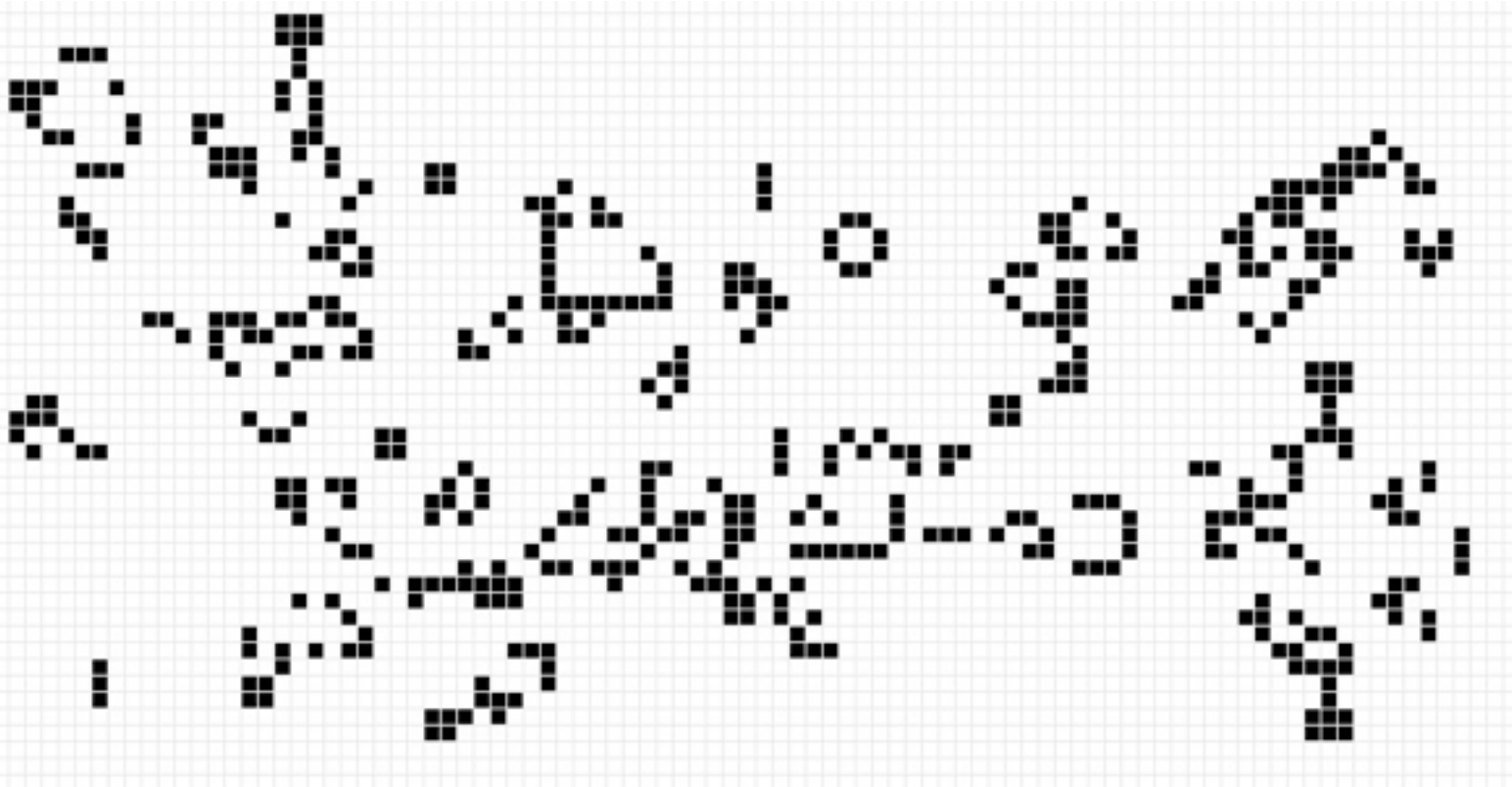
Collection Classes Part 3



Chris Piech

CS 106B
Lecture 4
Jan 13, 2015

Life is Due Friday



Join us at our upcoming info session to learn more about

DIVERSITYBASE

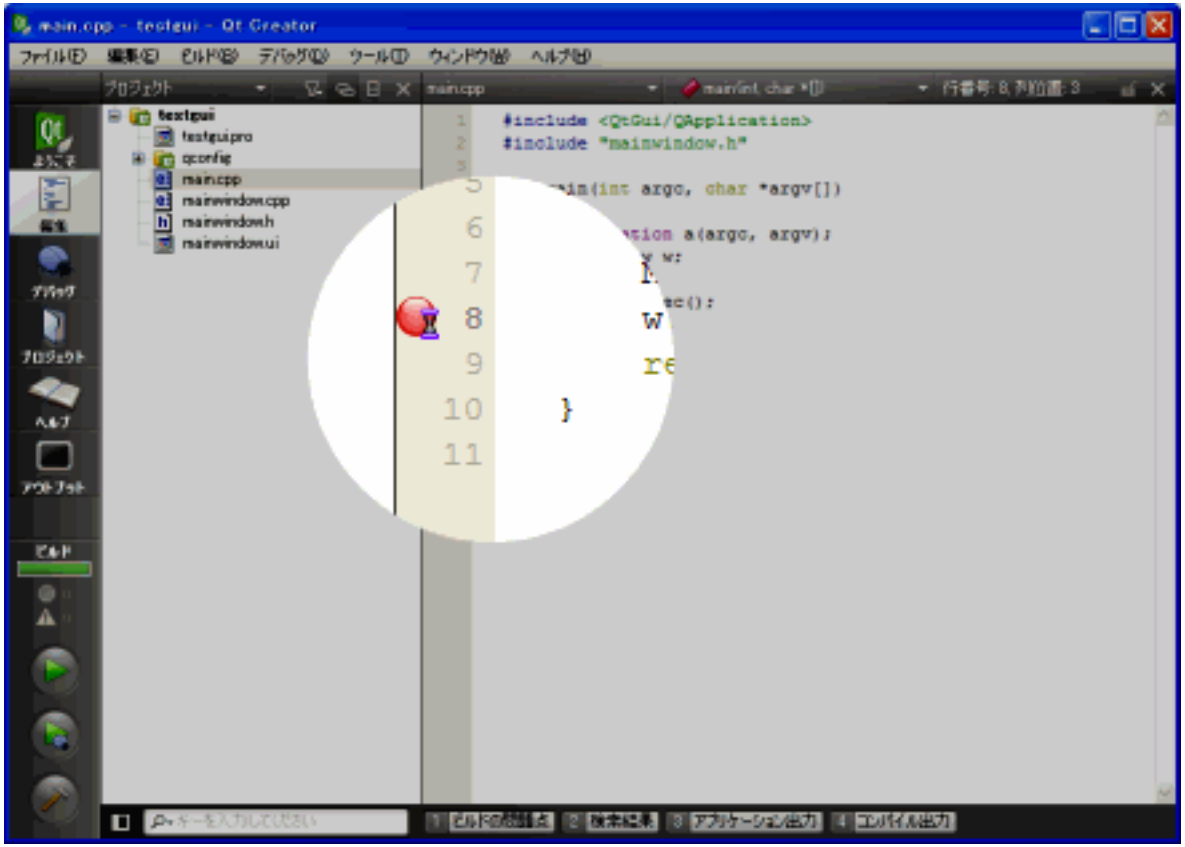
an organization dedicated to supporting people from underrepresented backgrounds in Computer Science with a focus on understanding the intersectionality of those backgrounds

THURSDAY, JANUARY 14TH at 6PM

OLD UNION 200

FOR MORE INFO, CONTACT:
PATRICIA PEROZO (PPEROZO@STANFORD.EDU)

Break Points



Interesting Puzzle

Counterfeiter

User

You (Distributor)

Interesting Puzzle

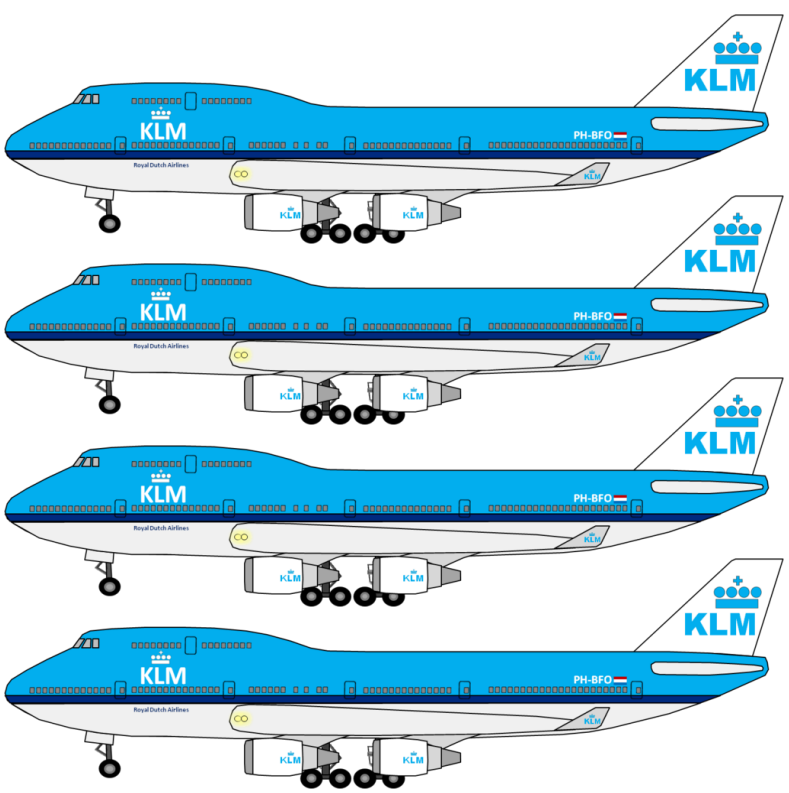
Counterfeiter

User

You (Distributor)

Fake Medicine is a Problem

700,000 deaths a year from fake malaria and tuberculosis drugs [1]



Equivalent of this many crashes per day

[1] http://www.un.org/africarenewal/magazine/may-2013/counterfeit-drugs-raise-africa%E2%80%99s-temperature

Interesting Puzzle

Counterfeiter

User

You (Distributor)

Real Life Challenge

Counterfeiter

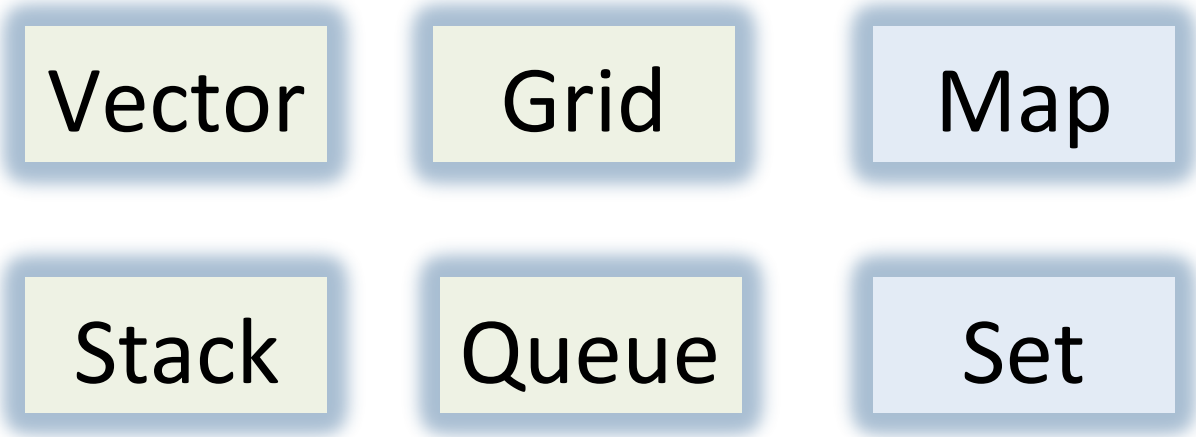
You (Distributor)

User

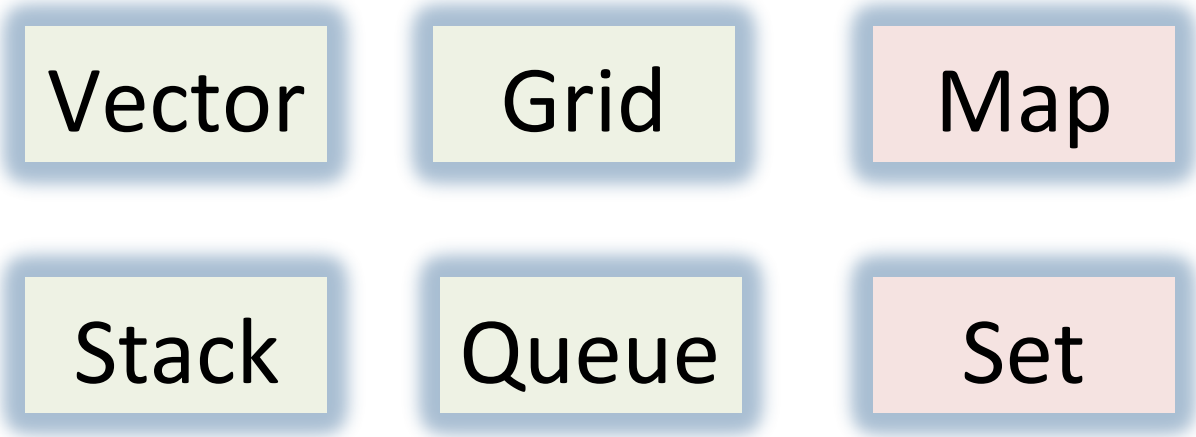
Solution?

Friday

Collections



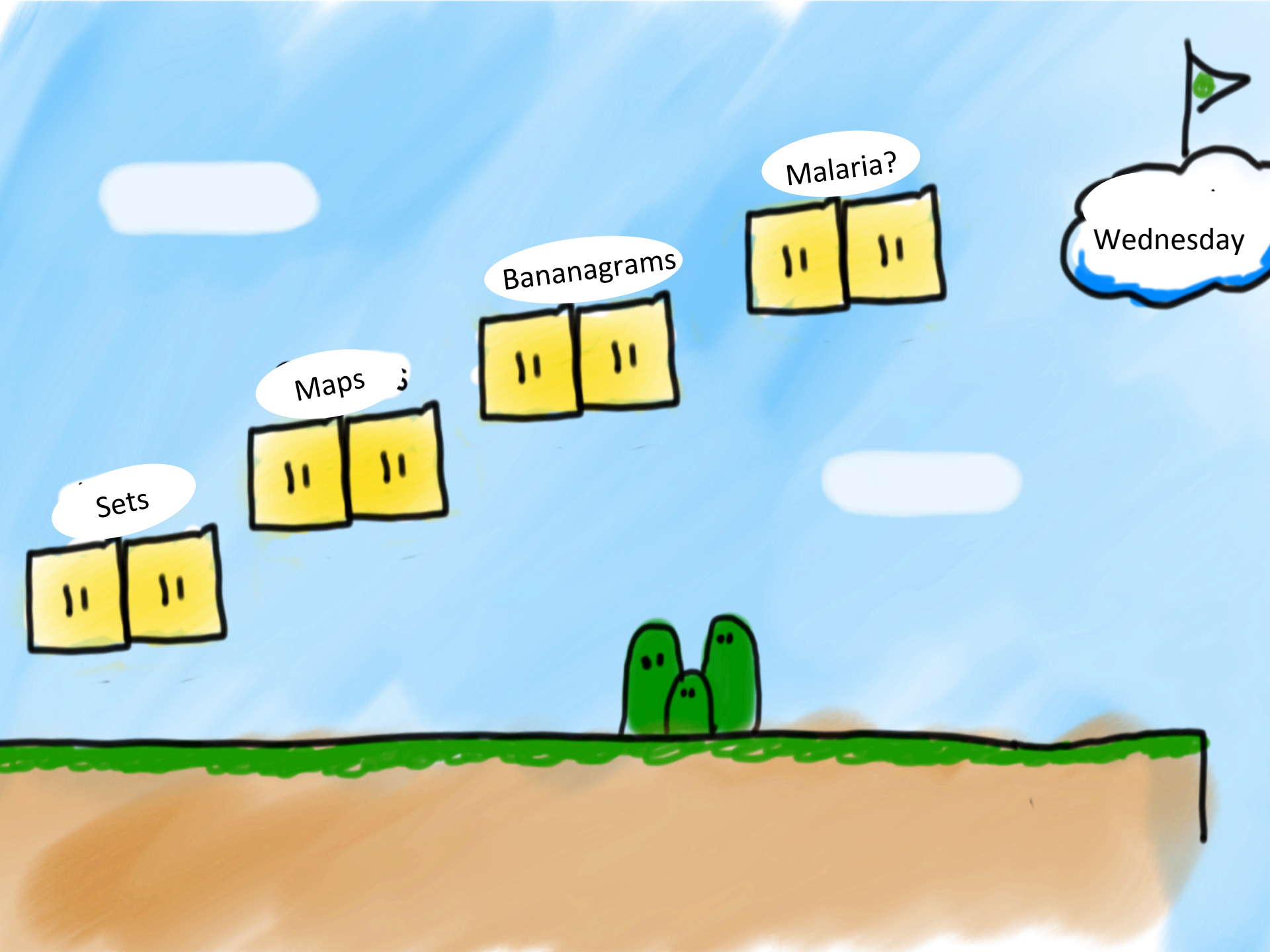
Collections

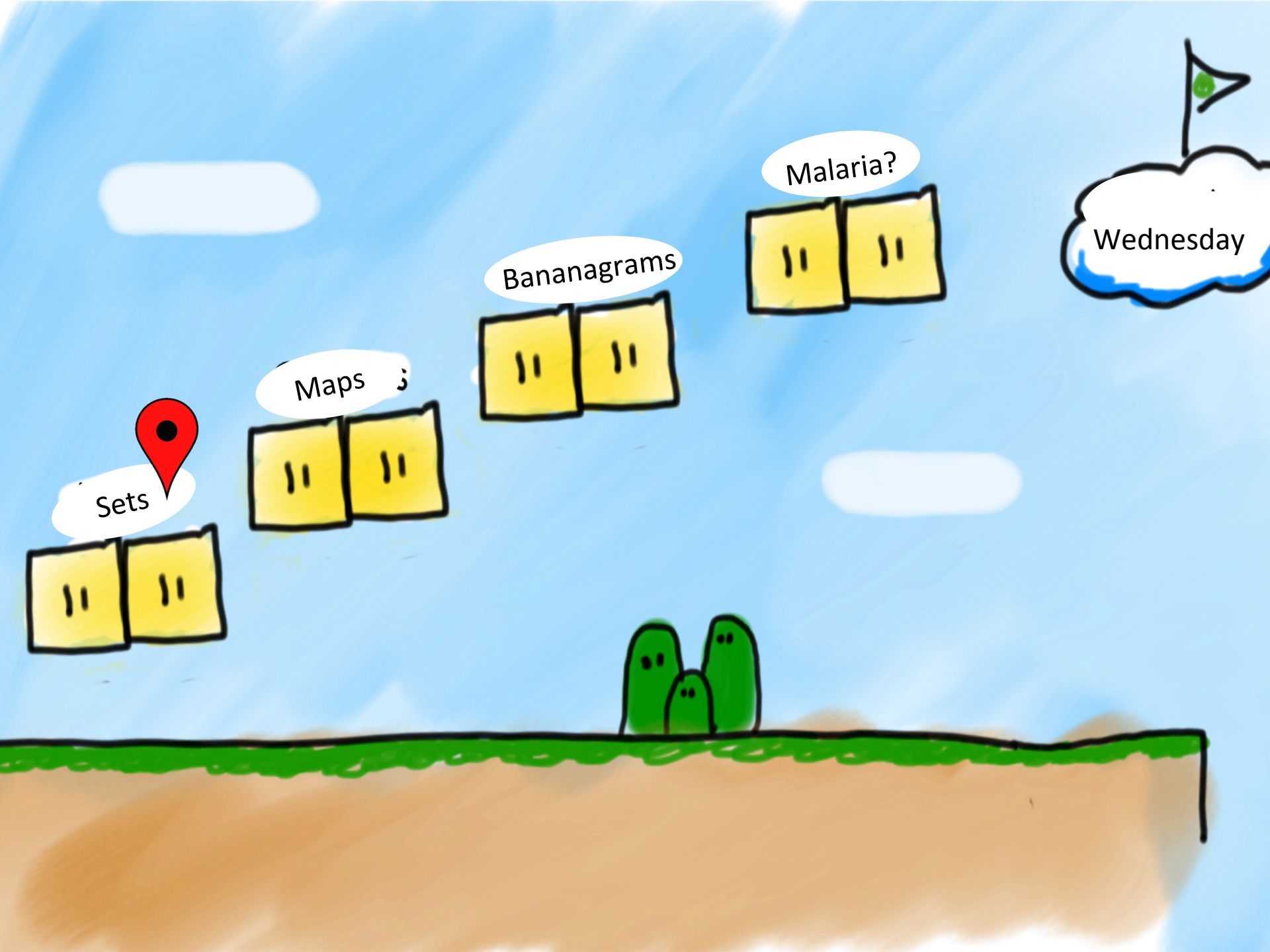


Today's Goals

1. Learn how to use Sets
2. Learn how to use Maps

See a previously never seen before computer program

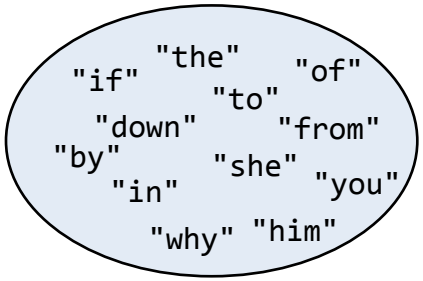

Sets
Maps
Bananagrams
Malaria?
Wednesday


Sets
Maps
Bananagrams
Malaria?
Wednesday

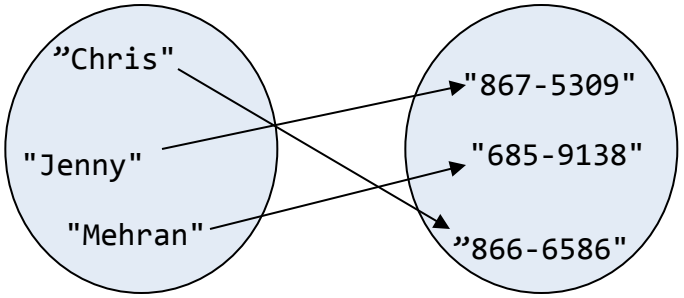
Sets and Maps

Set: Collection of elements with no duplicates;
fast for searching.

Map: Key/value pairs;
Use a key to find its associated value.



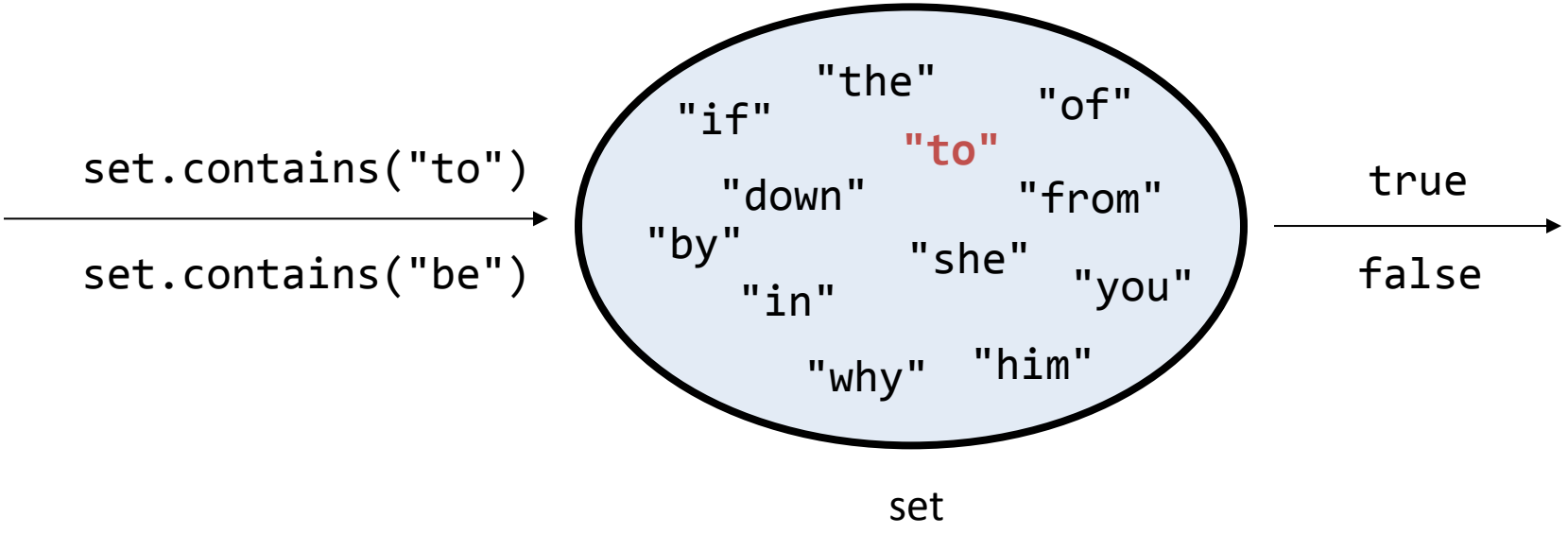
set



map

Problem #1: Count Unique Words

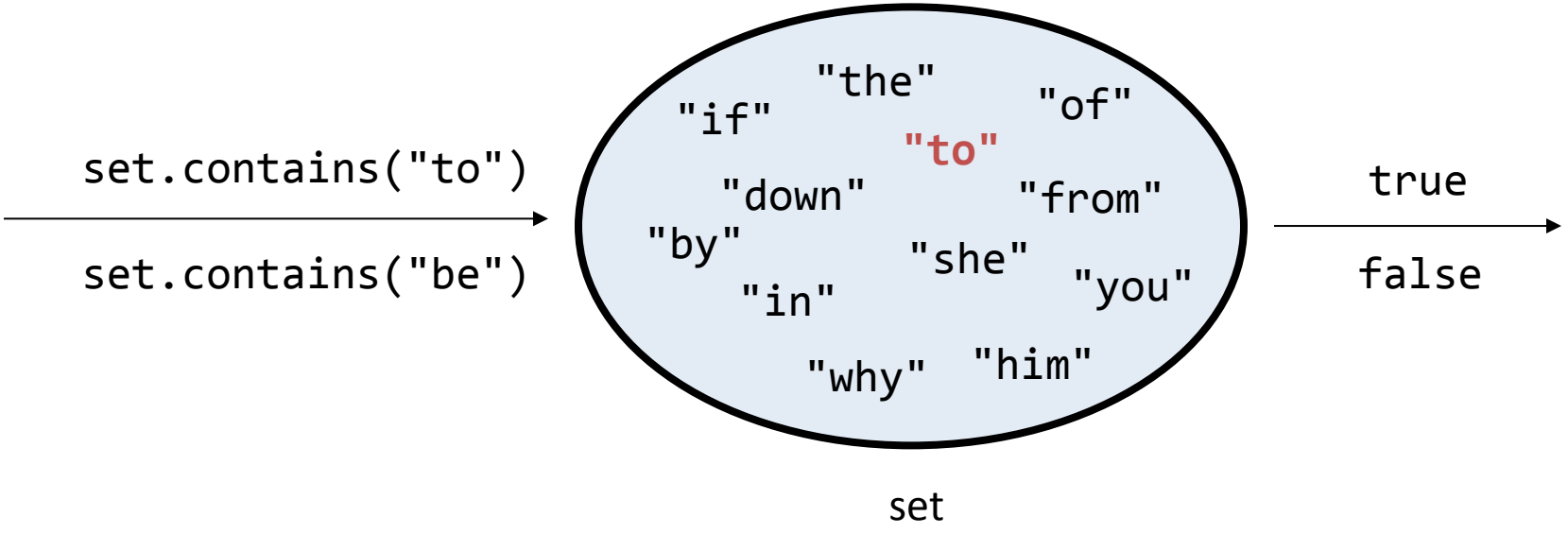
Sets


set.contains("to")
set.contains("be")
"the"
"if"
"of"
"to"
"down"
"from"
"by"
"she"
"you"
"in"
"why"
"him"
true
false
set

Sets

Set: A collection of unique values (no duplicates allowed)

- add, remove, search (contains) Fast
- We don't think of a set as having any indexes



The Set Essentials

`set.size()` Returns the number of elements in the set.
`set.add(value)` Adds a new value to the set (ignores it if the value already was in the set).
`Set.contains(value)` Return true if the value is in the set.

Looping Over a Set

```
for (type name : collection) {
    statements;
}
```

Looping Over a Set

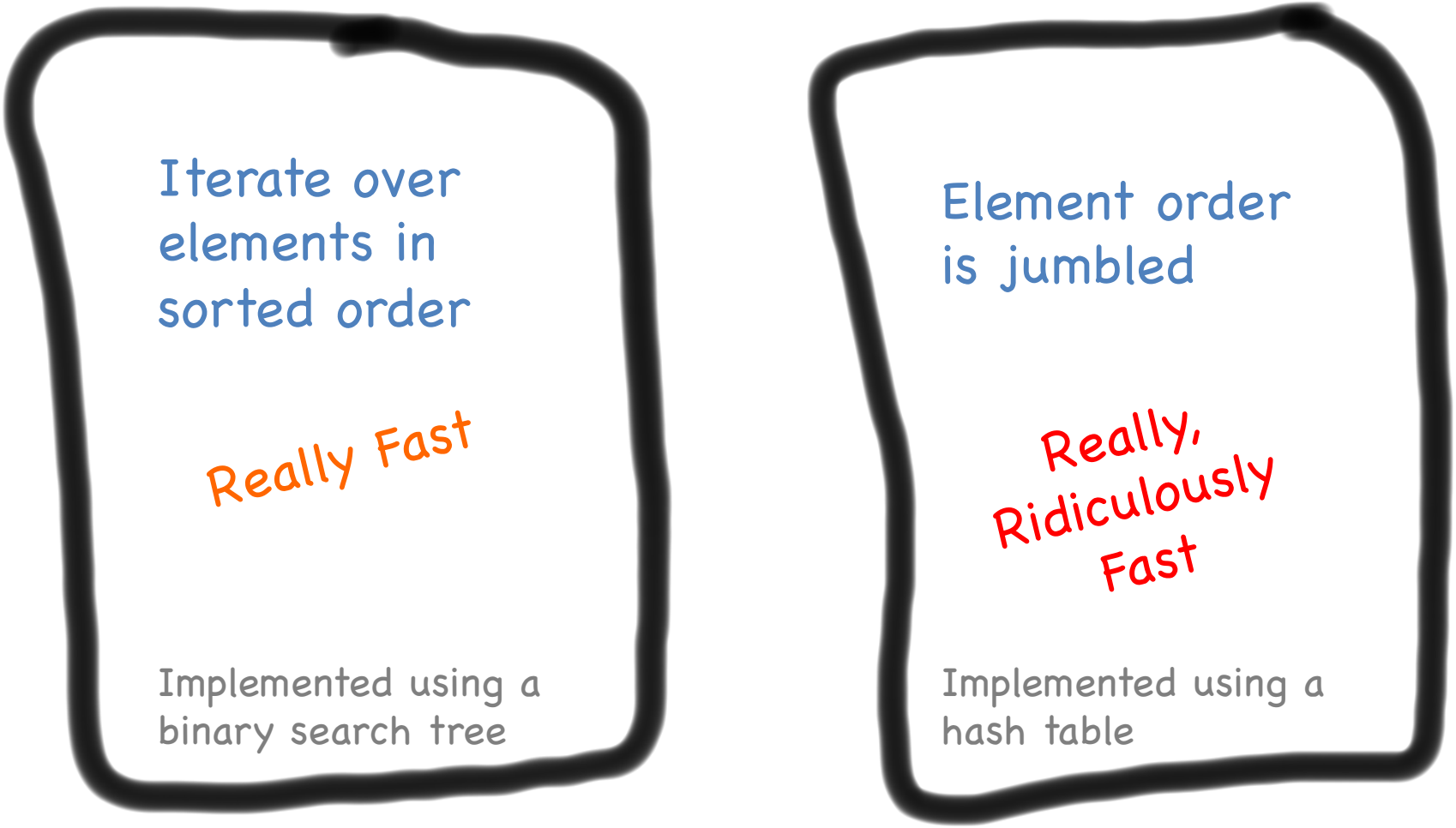
```
for (type name : collection) {
    statements;
}
```

The "for-each" loop provides a clean syntax for looping over the elements of a `Set`, `Vector`, or most other collections.

Sets have no indexes;
can't use a normal `for` loop and `get` each element `[i]`

```
for (int i = 0; i < set.size(); i++) {
    do something with set[i];          // does not compile
}
```

Types of Sets



Simple Example

```
Set<string> friends;
friends.add(“waddie”);
friends.add(“megan”);
cout << friends.contains(“voldemort”) << endl;
for(string person : friends) {
   cout << person << endl;
}
```


Qt

Set Operands

s1 == ***s2***	true if the sets contain exactly the same elements
s1 != ***s2***	true if the sets don't contain the same elements
s1 + ***s2***	returns the union of s1 and s2 (elements from either)
s1 * ***s2***	returns intersection of s1 and s2 (elements in both)
s1 - ***s2***	returns difference of s1, s2 (elements in s1 but not s2)

Set Operands

```
int main() {
    Set<string> allStudents = loadStanford();

    Set<string> left;
    for(string student : allStudents){
        if(audienceLeft(student)) {
            left.add(student);
        }
    }

    Set<string> hats;
    for(string student : allStudents){
        if(isWearingHat(student)) {
            hats.add(student);
        }
    }

    // more code coming...

}
```

Set Operands

```
int main() {
    Set<string> allStudents = loadStanford();

    Set<string> left;
    for(string student : allStudents){
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    for(string student : allStudents){
        if(isWearingHat(student)) {
            hats.add(student);
        }
    }

    // more code coming...

}
```

Students on the audience left of the stage

Set Operands

```
int main() {
    Set<string> allStudents = loadStanford();

    Set<string> left;
    for(string student : allStudents){
        if(audienceLeft(student)) {
            left.add(student);
        }
    }

    Set<string> hats;
    for(string student : allStudents){
        if(isWearingHat(student)) {
            hats.add(student);
        }
    }

    // more code coming...

}
```

Students wearing hats

Set Operands

```
allStudents, hats, left
```

Set Operands

```
allStudents, hats, left
```

```
stand(allStudents);
```

Set Operands

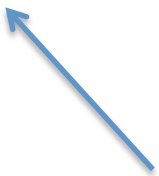
```
allStudents, hats, left
```

```
stand(left);
```

Set Operands

```
allStudents, hats, left
```

```
Set<string> combine;
combine = left + hats;
```



Elements in *either* set

Set Operands

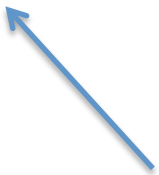
allStudents, hats, left

```
Set<string> combine;
combine = left + hats;
stand(combine);
```

Set Operands

```
allStudents, hats, left
```

```
Set<string> combine;
combine = left * hats;
```



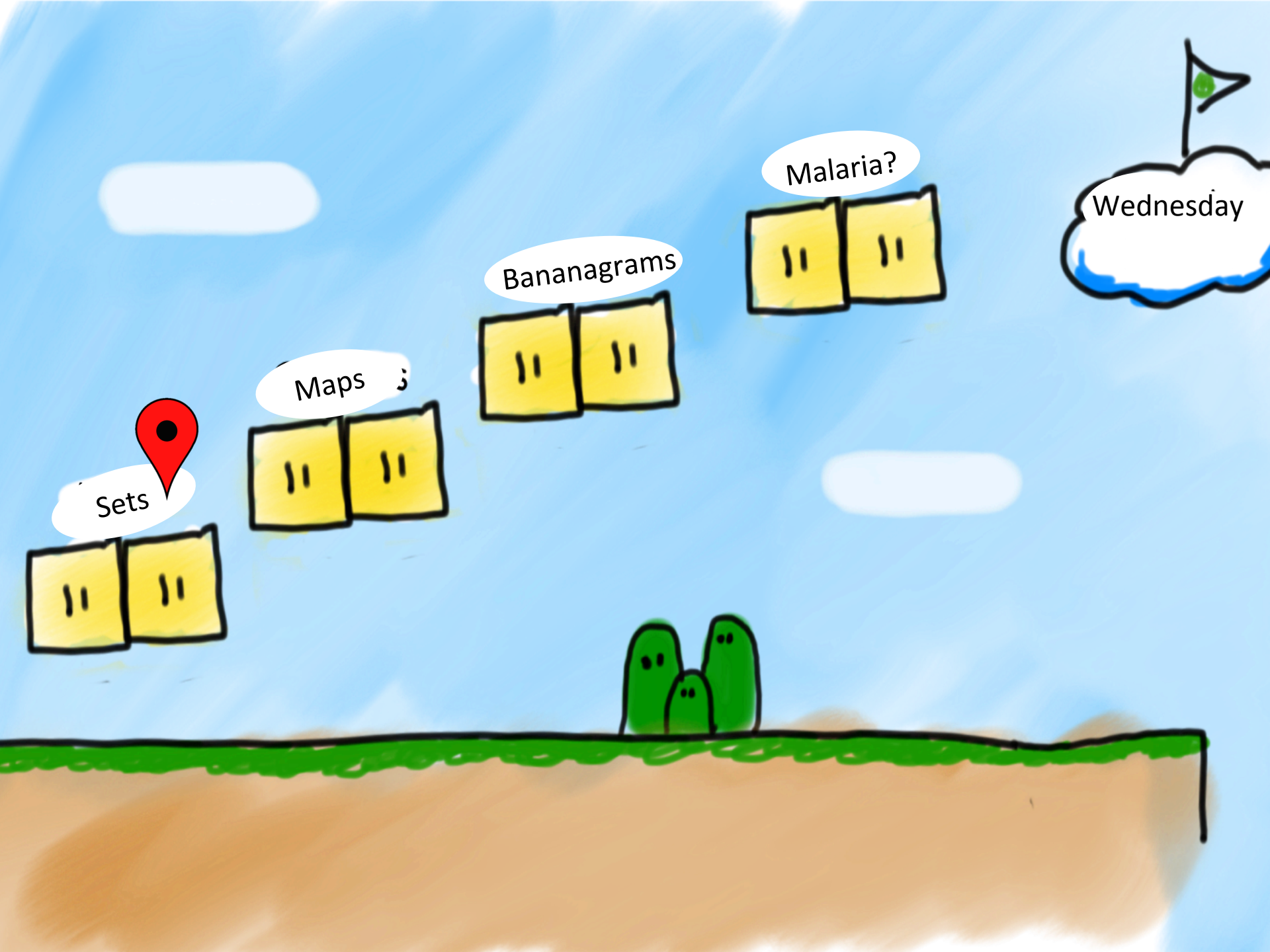
Elements in *both* sets

Set Operands

allStudents, hats, left

```
Set<string> combine;
combine = left * hats;
stand(combine);
```

Set Operands


Sets
Maps
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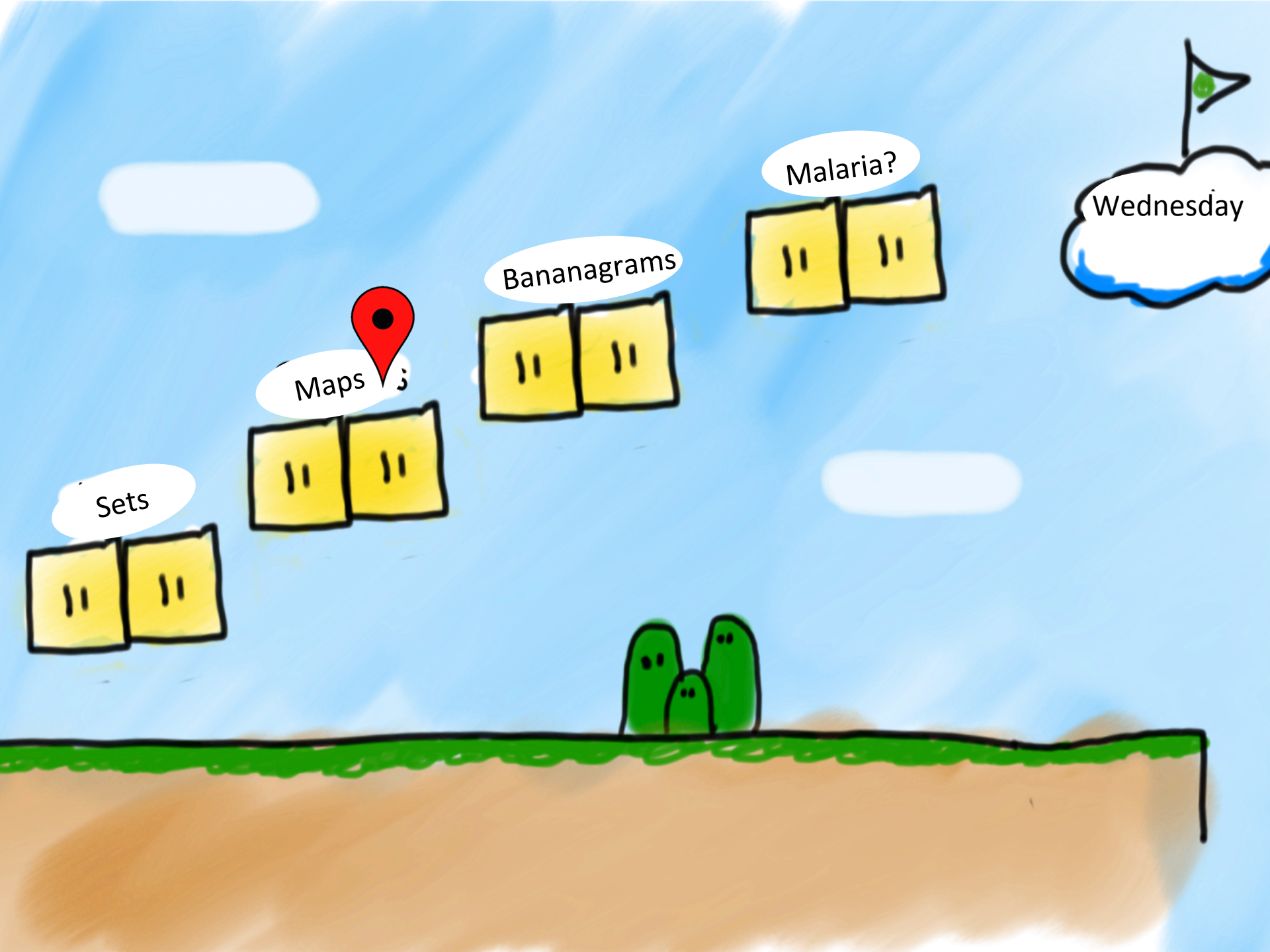
Sets
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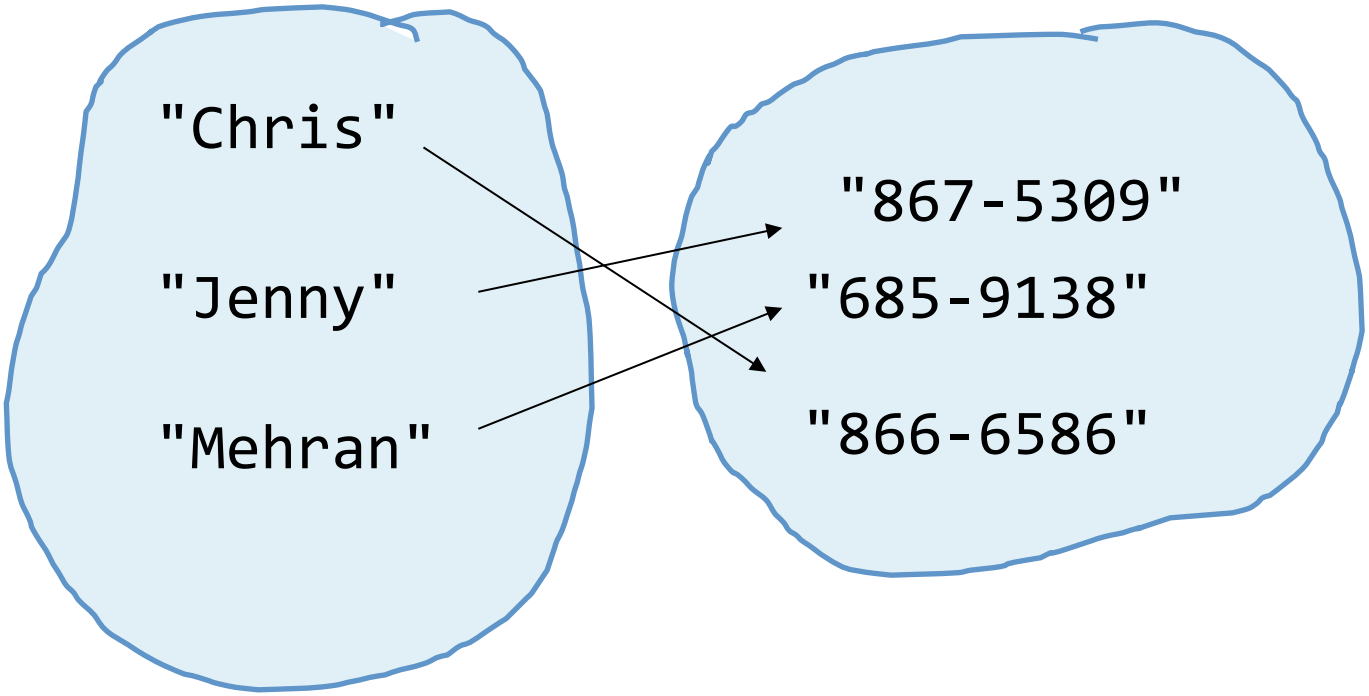
Maps

map: A collection of pairs (*k*, *v*), sometimes called key/value pairs, where *v* can be found quickly if you know *k*.

a.k.a. dictionary, associative array, hash

a generalization of an array, where the "indexes" need not be `int`s.

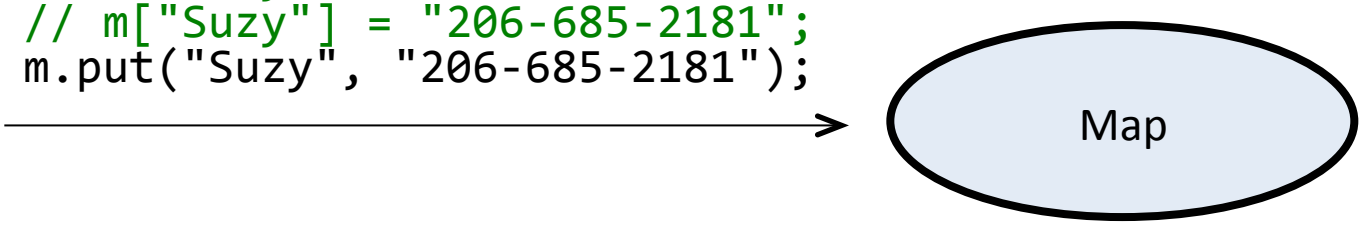


Using Maps

A map allows you to get from one half of a pair to the other.

Store an association from "Suzy" to "206-685-2181".

```
//      key          value
// m["Suzy"] = "206-685-2181";
m.put("Suzy", "206-685-2181");
```



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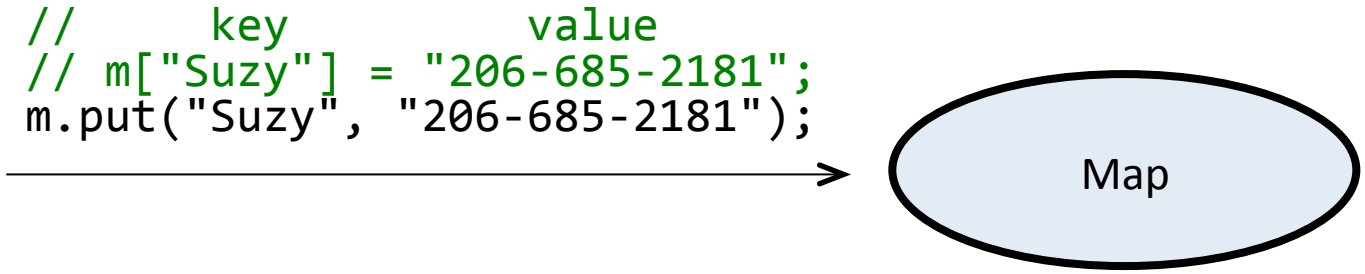
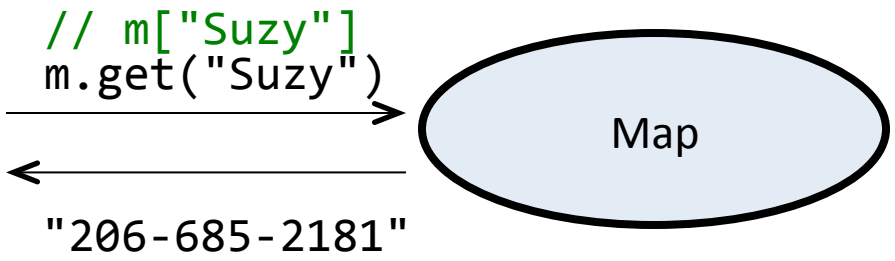


What was Suzy's phone number?



Map Example

Key = Title, Value = Article

Key:

"Mantis Shrimp"

Value:

Mantis shrimp

From Wikipedia, the free encyclopedia

Mantis shrimp or **stomatopods** are marine crustaceans, the members of the order **Stomatopoda**. Most species can grow to around 10 centimetres (3.9 in) in length, though a few species reach up to 38 cm (15 in).[2] The largest ever caught has a length of 46 cm (18 in) in the ocean near Fort Pierce, Florida of USA.[3] The carapace of mantis shrimp covers only the rear part of the head and the first four segments of the thorax. There are more than 400 species of Mantis shrimp. Varieties range from shades of brown to vivid colours, and are among the most important predators in many shallow, tropical and sub-tropical marine habitats. Despite being common, they are poorly understood as many species spend most of their life tucked away in burrows and holes.[4]

Mantis shrimp

Odontodactylus scyllarus

Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Subphylum:	Crustacea
Class:	Malacostraca
Subclass:	Hoplocarida
Order:	**Stomatopoda** Latreille, 1817

Superfamilies and families [1]

Bathysquilloidea

Key:

"Antelope Canyon"

Value:

Antelope Canyon is a slot canyon in the American Southwest. It is located on Navajo land east of Page, Arizona. Antelope Canyon includes two separate, photogenic slot canyon sections, referred to individually as *Upper Antelope Canyon* or *The Crack*; and *Antelope Canyon* or *The Corkscrew*.[2]

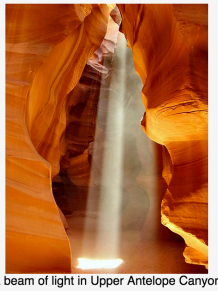
The Navajo name for Upper Antelope Canyon is Tsé bighánílíní, which means "the place where water runs through rocks." Lower Antelope Canyon is Hazdistazí (advertised as *"Hasdestwazi"* by the Navajo Parks and Recreation Department), or "spiral rock arches." Both are located within the LeChee Chapter of the Navajo Nation.[4]

Contents [hide]

1 Geology
2 Tourism and photography
2.1 Upper Antelope Canyon

Antelope Canyon

Tsé bighánílíní dóó Hazdistazí (Navajo)



A beam of light in Upper Antelope Canyon

Map Example

Key = Title, Value = Article

Key:

"Mantis Shrimp"

Value:

```
"<p><b>Mantis shrimp</b>
or <b>stomatopods</b> are
marine <a href="/wiki/
Crustacean"
title="Crustacean">crusta
ceans</a>, the members of
the <a href="/wiki/
Order_(biology)"
title="Order
(biology)">order</a>
<b>Stomatopoda</b>.
though a few species
reach up to 38 ..."
```

Key:

"Antelope Canyon"

Value:

Antelope Canyon is a slot canyon in the American Southwest. It is located on Navajo land east of Page, Arizona. Antelope Canyon includes two separate, photogenic slot canyon sections, referred to individually as *Upper Antelope Canyon* or *The Crack*; and *Antelope Canyon* or *The Corkscrew*.[2]

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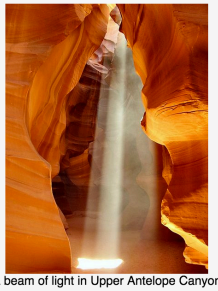


A beam of light in Upper Antelope Canyon

Creating a Map

Requires 2 type parameters:
one for keys, one for values.

```
// maps from string keys to
integer values
Map<string, int> votes;
```

Map Members

`m.clear();`	removes all key/value pairs from the map
`m.containsKey(key)`	returns `true` if the map contains a mapping for the given key
`m[key]` or `m.get(key)`	returns the value mapped to the given key; if key not found, **adds** it with a default value (e.g. 0, "")
`m.isEmpty()`	returns `true` if the map contains no k/v pairs (size 0)
`m.keys()`	returns a `Vector` copy of all keys in the map
`m[key] = value;` or `m.put(key, value);`	adds a mapping from the given key to the given value; if the key already exists, **replaces** its value with the given one
`m.remove(key);`	removes any existing mapping for the given key
`m.size()`	returns the number of key/value pairs in the map
`m.toString()`	returns a string such as `"{a:90, d:60, c:70}"`
`m.values()`	returns a `Vector` copy of all values in the map

Map Example

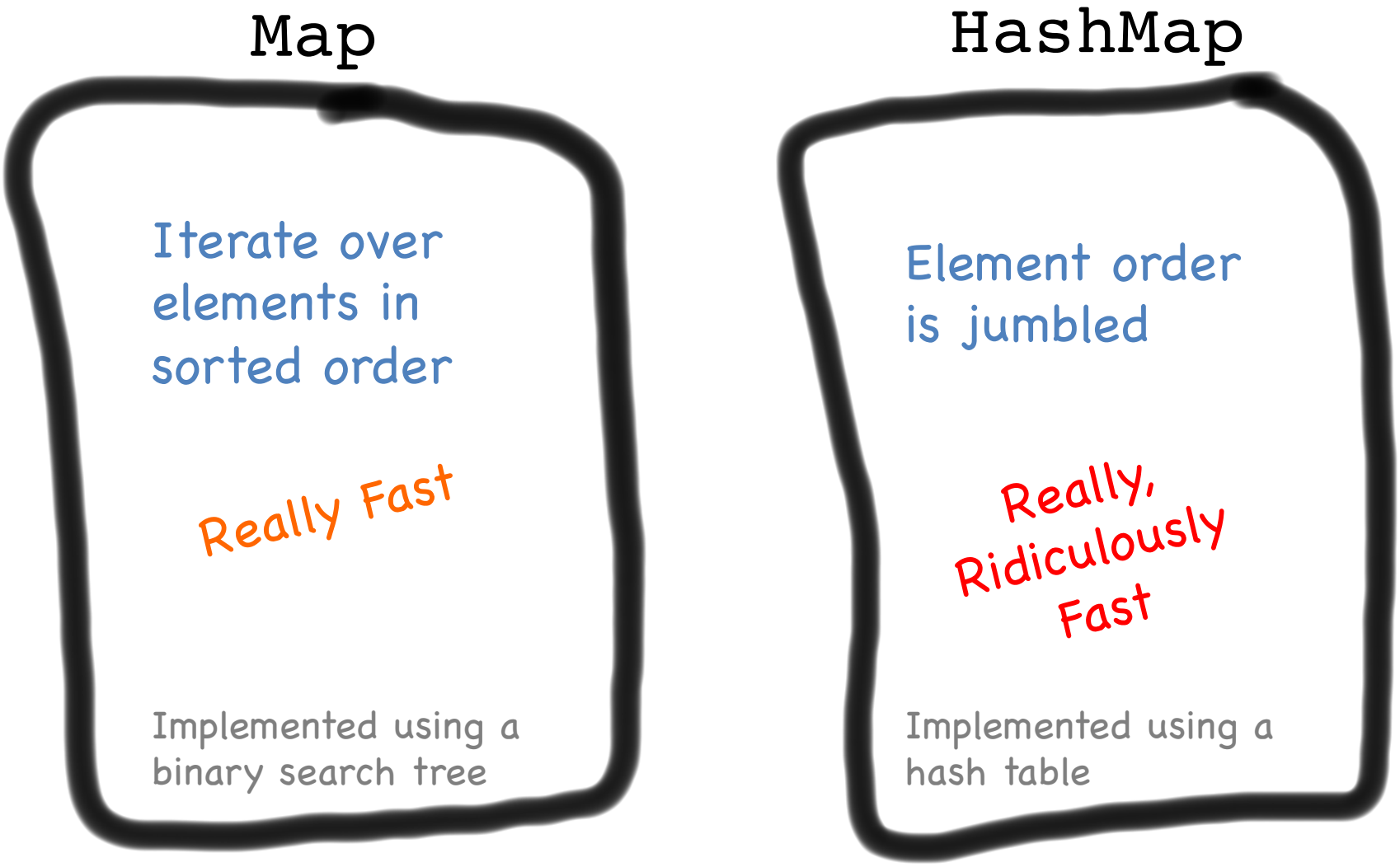
```
Map<string, string> wiki;

// adds name / text pair to dataset
wiki.put("Stanford Band", articleHTML);

// returns corresponding articleHTML
wiki.get("Mantis Shrimp");

// removes the article
remove("Trump");
```

Types of Maps



Tallies

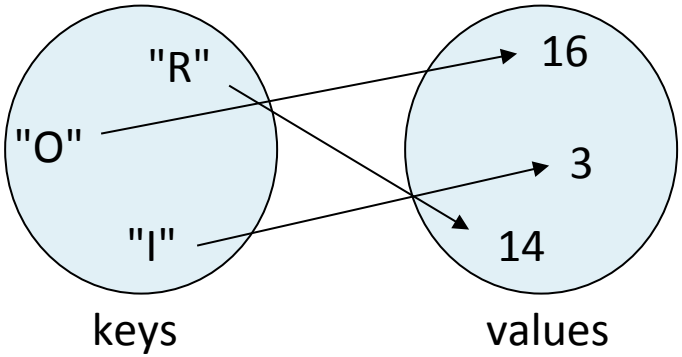
count digits: 22092310907

index	0	1	2	3	4	5	6	7	8	9
value	3	1	3	0	0	0	0	1	0	2

Tallies

```
// (R)omney, (O)bama, (I)ndependent
count votes:
"ROOOOOORRRRROOOOOORORRIRORRIRORIO"
```

key	"R"	"O"	"I"
value	14	16	3



Problem #2: Tally Words

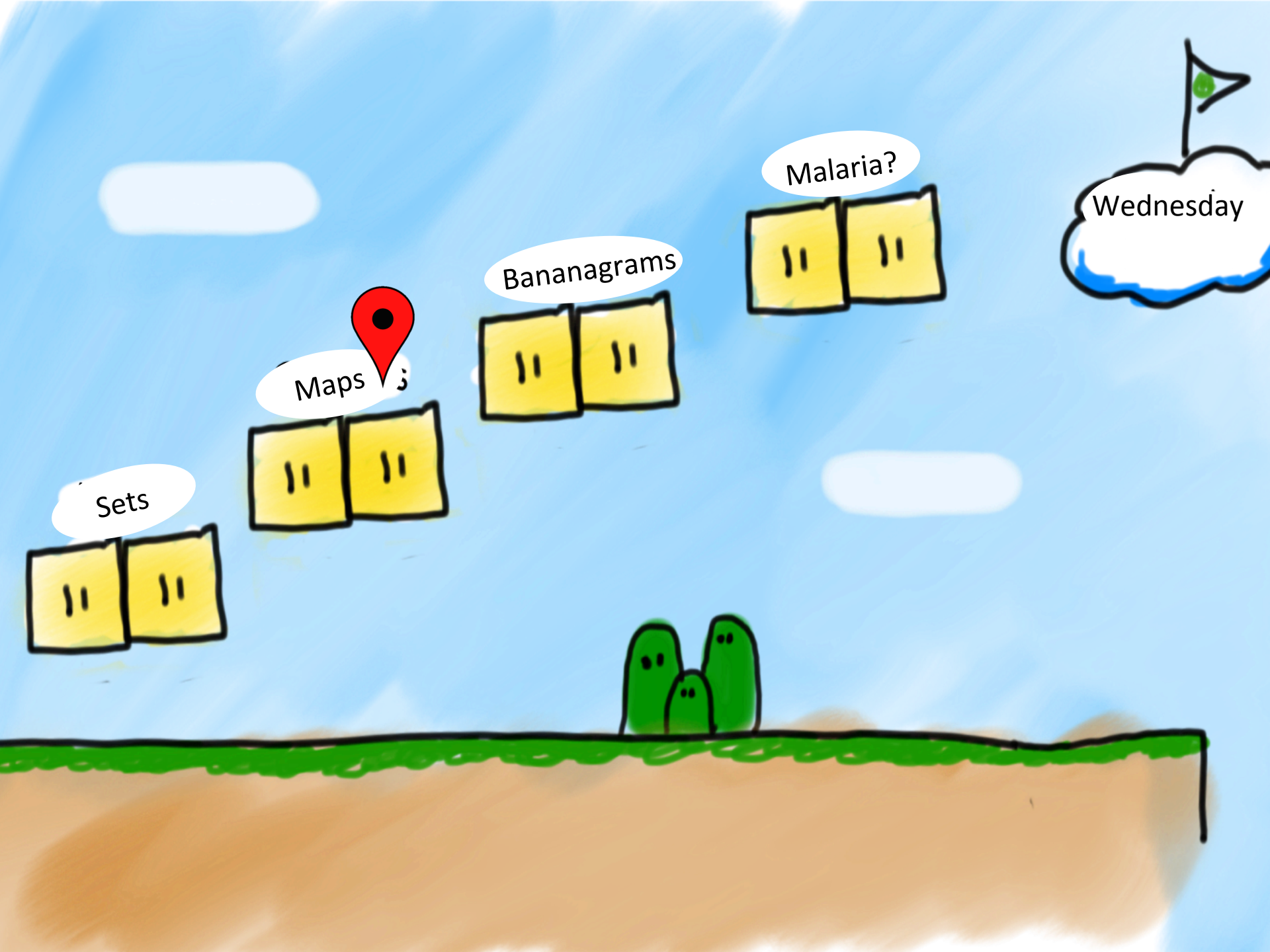
Looping Over a Map

```
Map<string, double> gpa = load();

for (string name : gpa) {
    cout << name << "'s GPA is ";
    cout << gpa[name] << endl;
}
```

*The order is unpredictable in a HashMap


Sets, good
Maps, good
Sets + Maps, good


Sets
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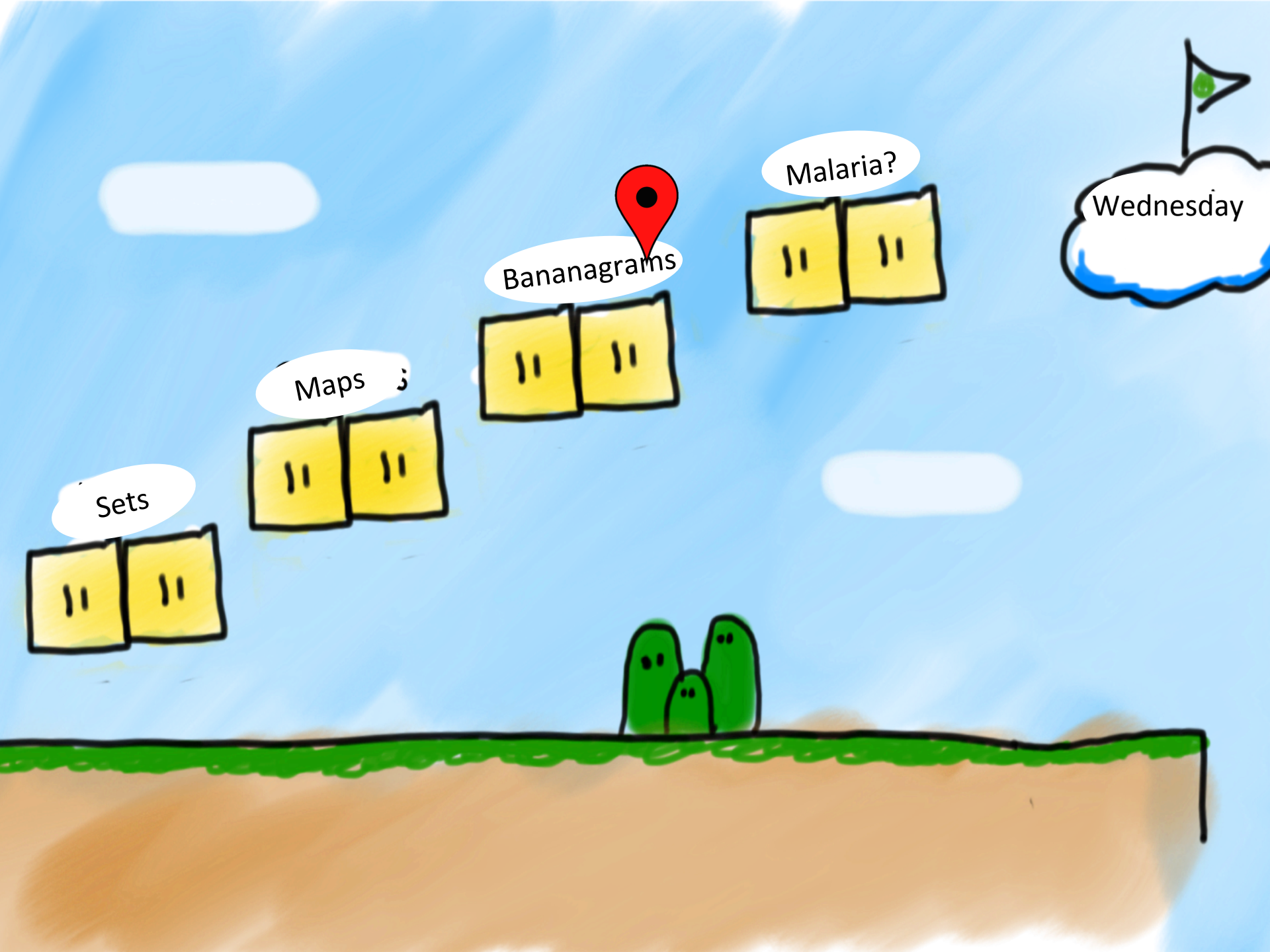
Sets
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Wednesday

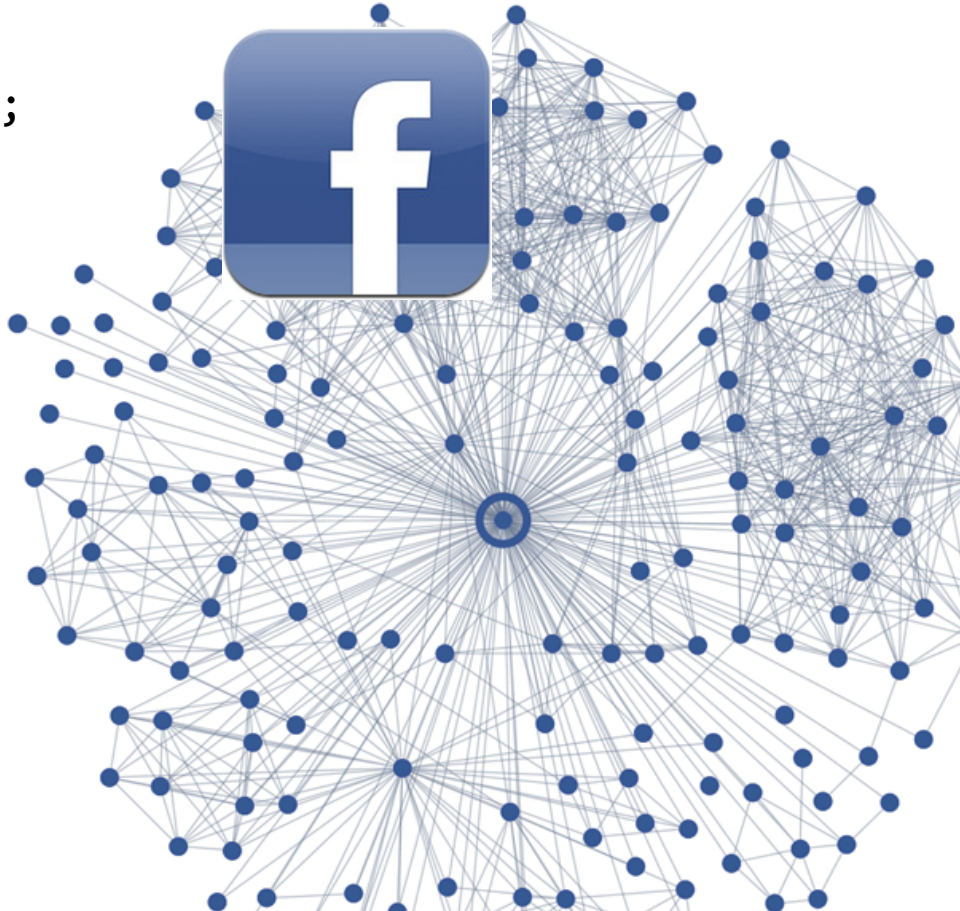
Compound Exampld

Example: how would you store people's Facebook friends?

- i.e., I need to quickly look up the names of all of Jimmy's buddies, or test whether a given person is a friend of Jimmy's or not.

```
Map<string, Set<string> > pals;
pals["Jim"] += "Kate";
pals["Jim"] += "Bill";
pals["Mar"] += "Stuart";
pals["Jim"] += "Cindy";
pals["Hal"] += "Mar";
pals["Mar"] += "Helene";
cout << pals << endl;

// {Hal:{Mar},
//  Jim:{Bill, Cindy, Kate},
//  Mar:{Helene, Stuart}}
```



Anagram Exercise

Write a program to find all anagrams of a word the user types.

```
Type a word [Enter to quit]: scared
Anagrams of scared:
cadres
cedars
sacred
scared
```

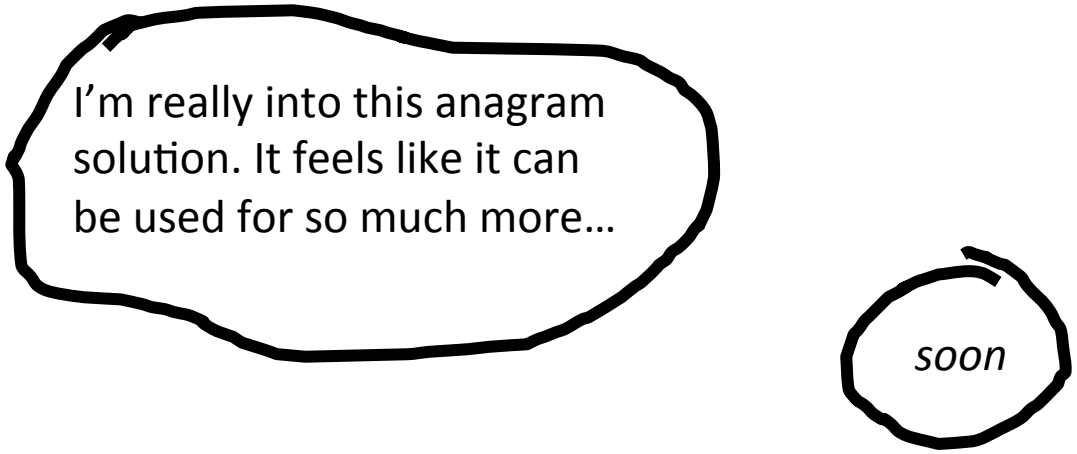
What is the appropriate collection to use to solve this problem?

Hint: Use a compound collection...

Aka how to beat your friends at word games

Problem #3: Anagrams

Me This Morning



Google

Bananagrams artificial intelligence

Me This Morning

Bananagrams vs computer

Bananagrams online

number of legal moves in bananagrams

We may be the first…

Bananagrams

http://mysummeratamonastery.blogspot.com/2013/07/cel-rotis-stolen-money-and-bananagrams.html

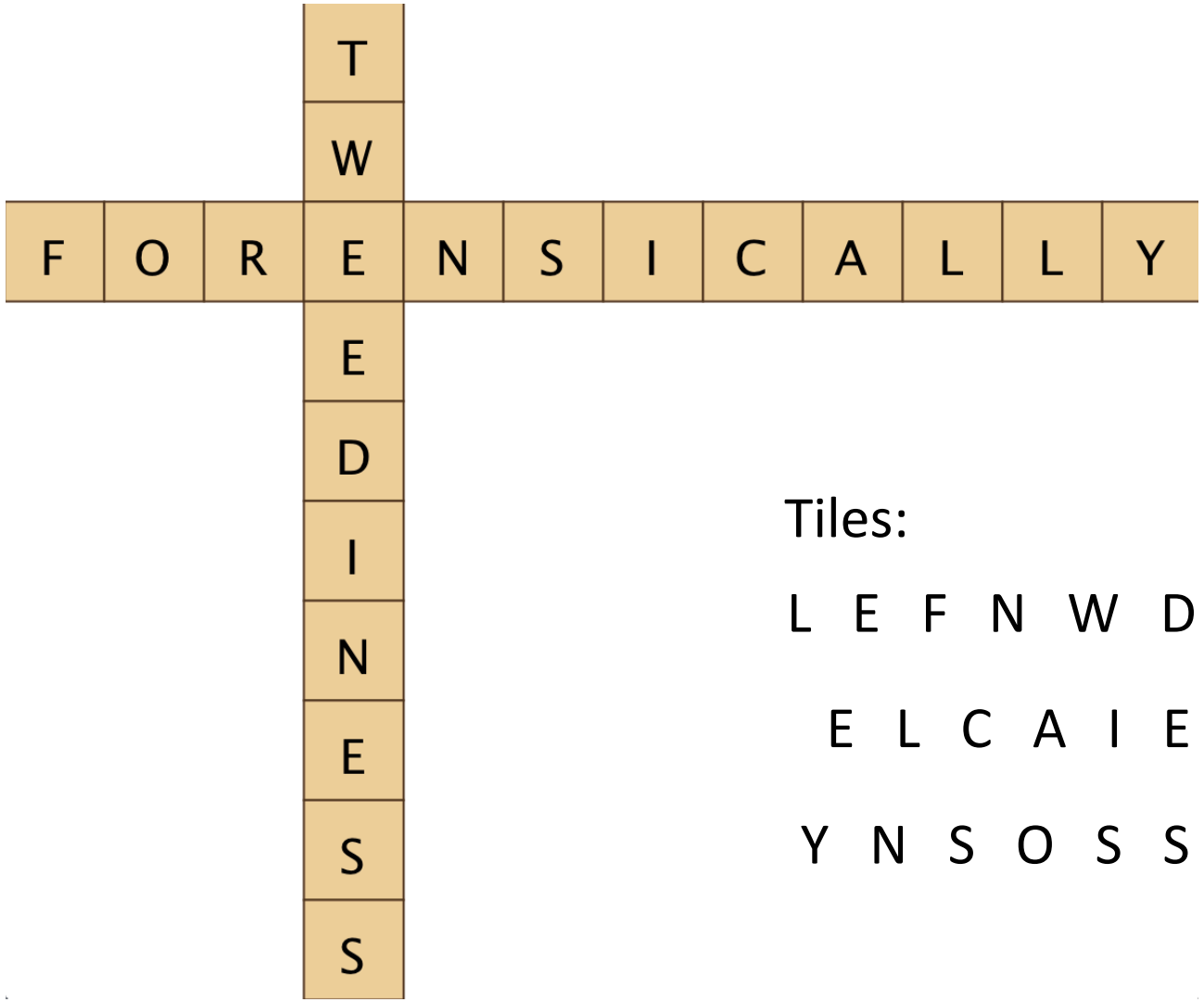
Bananagrams

L E F N W D R

E L C A I E I

Y N S O S S T

Bananagrams



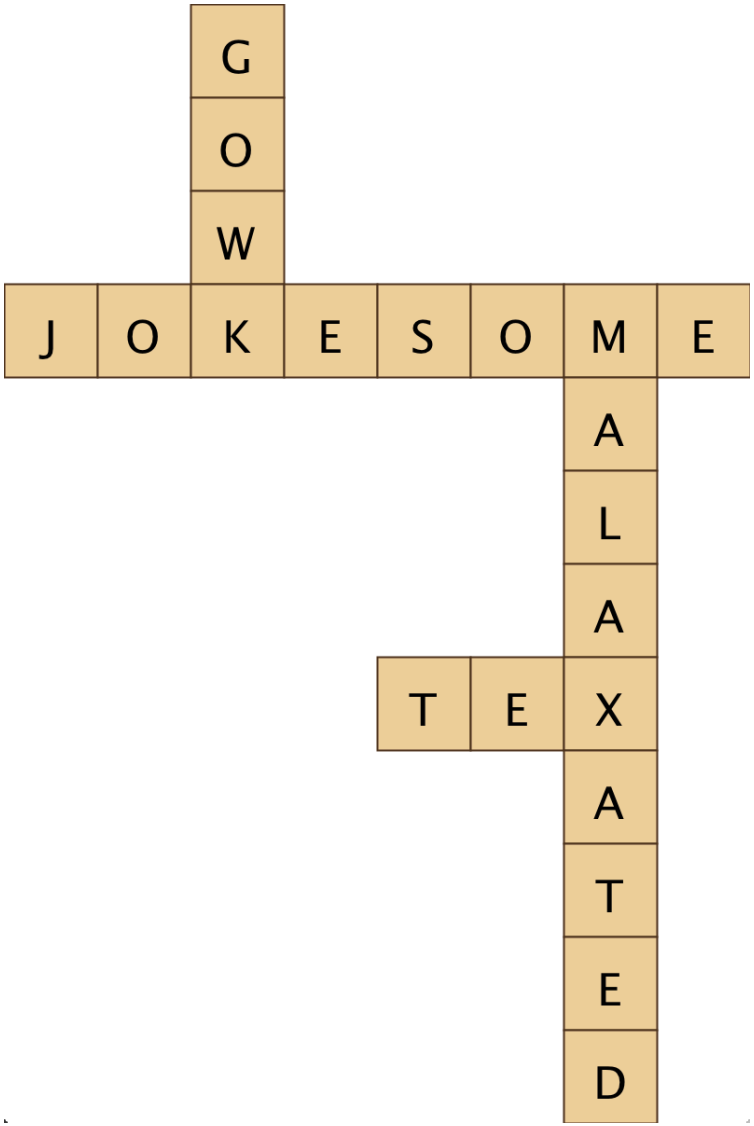
Tiles:

L E F N W D R

E L C A I E I

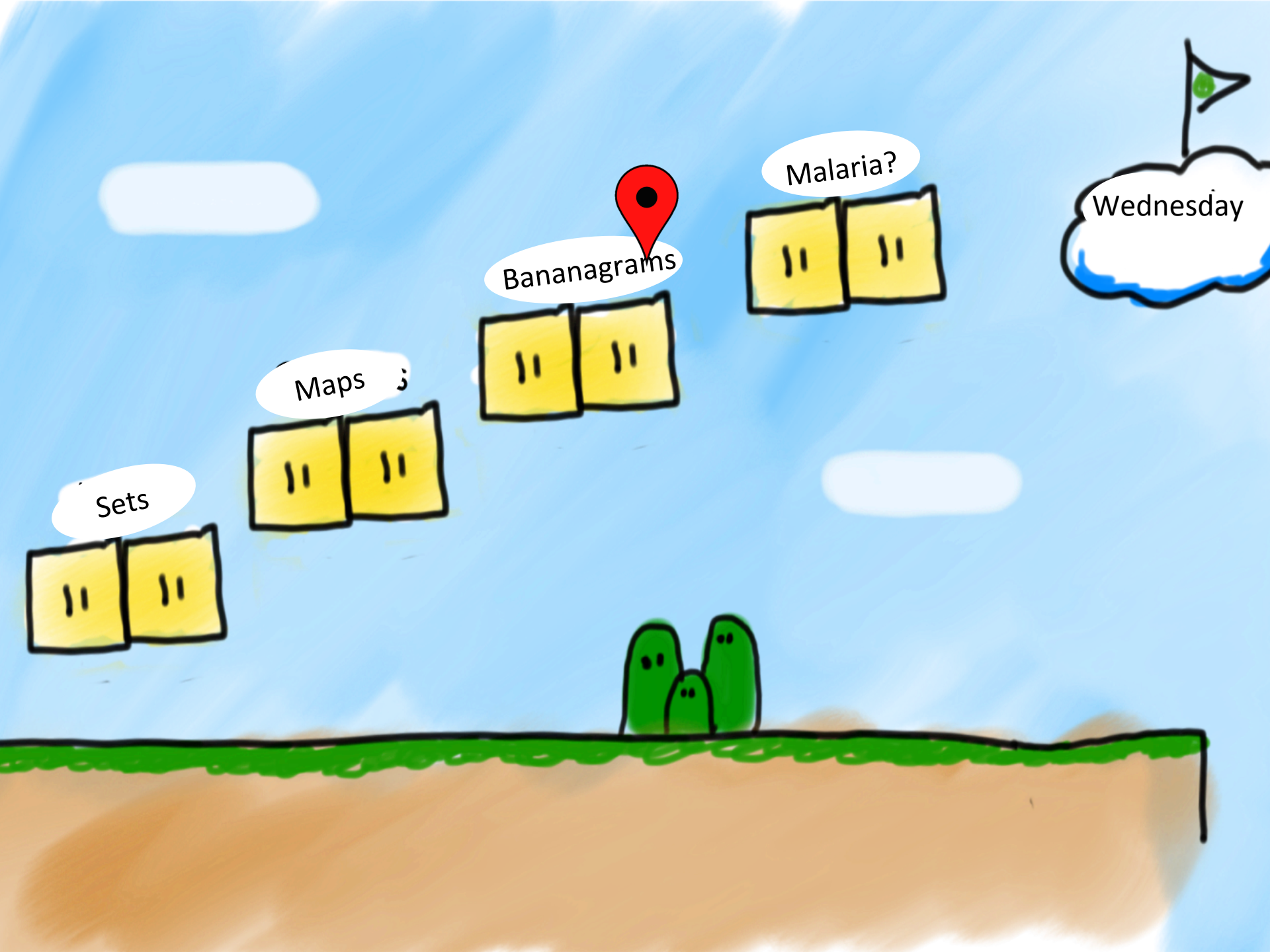
Y N S O S S T

Bananagrams



Tiles: DTGEMAOTOWKJEAAESELXO

That’s all folks.


Sets
Maps
Bananagrams
Malaria?
Wednesday

Today's Goals

1. Learn how to use Sets
2. Learn how to use Maps

See a previously never seen before computer program

Interesting Puzzle

Counterfeiter

User

You (Distributor)