Maps
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Make a keyboard
Where are we?
Where are we?

• Karel the Robot
• Java
• Console Programs
• Graphics Programs
• Text Processing
• Data Structures
• GUIs
• Defining our own Variable Types
Collections High Level

List:  ArrayList<type>
Array:  type[]
Matrix:  type[][]
Collections High Level

List:   ArrayList<String>
Array:  double[]
Matrix: int[][]
ArrayList

index -> value
Arrays
index -> value
Matrix
(row, col) -> value
Maps can have any type for key

Many examples
HashMap
key -> value

Can be any type
Simple Example

1. Make a new HashMap of animal sounds

2. Add elements:
   Put [key = “dog”, value = “bark”]
   Put [key=“cat”, value=“meow”]
   Put [key=“seal”, value=“ow ow ow”]

3. Get elements:
   Get [key = “dog”]
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   Put [key="cat", value="meow"]
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   Put [key = “dog”, value = “bark”]
   Put [key=“cat”, value=“meow”]
   Put [key=“seal”, value=“ow ow ow”]

3. Get elements:
   Get [key = “cat”]
1. Make a new HashMap of animal sound

2. Add elements:
   Put [key = “dog”, value = “bark”]
   Put [key=“cat”, value=“meow”]
   Put [key=“seal”, value=“ow ow ow”]

3. Get elements:
   Get [key = “cat”]
1. Make a new HashMap of animal sound

2. Add elements:
   Put [key = “dog”, value = “bark” ]
   Put [key=“cat”, value=“meow” ]
   Put [key=“seal”, value=“ow ow ow” ]

3. Get elements:
   Get [key = “cat”]
HashMap<String, String> animalSoundMap = new HashMap<String, String>();
My First Map

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new HashMap<String, String>();
My First Map

```java
HashMap<String, String> animalSoundMap =
    new HashMap<String, String>();
```
My First Map

HashMap<String, String> animalSoundMap = new HashMap<String, String>();

animalSoundMap.put("dog", "bark");
My First Map

HashMap<String, String> animalSoundMap = new HashMap<String, String>();

animalSoundMap.put("dog", "bark");
My First Map

```java
HashMap<String, String> animalSoundMap = new HashMap<>();

animalSoundMap.put("dog", "bark");
```
My First Map

```java
HashMap<String, String> animalSoundMap = new HashMap<String, String>();
animalSoundMap.put("dog", "bark");
```
My First Map

```java
HashMap<String, String> animalSoundMap = new HashMap<String, String>();

animalSoundMap.put("dog", "bark");

animalSoundMap.get("dog");
```
My First Map

HashMap<String, String> animalSoundMap =
    new HashMap<String, String>();

animalSoundMap.put("dog", "bark");

animalSoundMap.get("dog");
My First Map

HashMap<String, String> animalSoundMap = new HashMap<String, String>();

animalSoundMap.put("dog", "bark");

animalSoundMap.get("dog");
1. Make a new HashMap of animal sound

2. Add elements:
   Put [key = “dog”, value = “bark”]
   Put [key=“cat”, value=“meow”]
   Put [key=“seal”, value=“ow ow ow”]

3. Get elements:
   Get [key = “dog”]
// 1. Make a new map
HashMap<String, String> animalSoundMap =
    new HashMap<String, String>();

// 2. Put things into the map
animalSoundMap.put("dog", "woof");
animalSoundMap.put("cat", "meow");
animalSoundMap.put("seal", "ow ow ow");

// 3. Get things out of the map
animalSoundMap.get("dog");  // "woof"
My First Map

animalSoundMap

Values:
- "bark"
- "ow ow ow"
- "meow"

Keys:
- "dog"
- "seal"
- "cat"

// 1. Make a new map
HashMap<String, String> animalSoundMap =
    new HashMap<String, String>();

// 2. Put things into the map
animalSoundMap.put("dog", "woof");
animalSoundMap.put("cat", "meow");
animalSoundMap.put("seal", "ow ow ow");

// 3. Get things out of the map
animalSoundMap.get("dog"); // "woof"
animalSoundMap.get("fox"); // ?
brothers Vegard and Bård Ylvisåker

Circa 2013, Norway
But there’s one sound

animalSoundMap

Values: "bark" "ow ow ow" "meow"

Keys: "dog" "seal" "cat"

// 1. Make a new map
HashMap<String, String> animalSoundMap = new HashMap<String, String>();

// 2. Put things into the map
animalSoundMap.put("dog", "woof");
animalSoundMap.put("cat", "meow");
animalSoundMap.put("seal", "ow ow ow");

// 3. Get things out of the map
animalSoundMap.get("dog"); // "woof"
animalSoundMap.get("fox"); // ?
My First Map

animalSoundMap

Values:  
- "bark"
- "ow ow ow"
- "meow"

Keys:  
- "dog"
- "seal"
- "cat"

// 1. Make a new map
HashMap<String, String> animalSoundMap = new HashMap<String, String>();

// 2. Put things into the map
animalSoundMap.put("dog", "woof");
animalSoundMap.put("cat", "meow");
animalSoundMap.put("seal", "ow ow ow");

// 3. Get things out of the map
animalSoundMap.get("dog"); // "woof"
animalSoundMap.get("fox"); // null
1. Make a HashMap

\[ \text{HashMap}<\text{keyType}, \text{valueType}> \text{ myMap} = \]
\[ \text{new HashMap}<\text{keyType}, \text{valueType}>(); \]

2. Put and get values into a map

myMap.put(key, value);
myMap.get(key) // returns the corresponding value

3. Some useful other methods

int size = myMap.size();
myMap.containsKey(key); // returns true or false if key is in map
myMap.keySet();
myMap.remove(key); // make like a tree and leave!

4. Iterate using a foreach loop

for(keyType key : myMap.keySet()) { // not ordered
    myMap.get(key); // do something with the key/value pair
}
Mpedigree?
Make a keyboard

keyboardC.txt

C4.wav
100.0
0
50
200
true
Q
D4.wav
150.0
0
50
200
true
W
E4.wav
200.0
0
50
200
true
E
Why is this so fast?

Google

mantis shrimp colors

About 1,870,000 results (0.54 seconds)

Humans and many other primates have three; some birds and reptiles have four photoreceptors. Certain butterflies can even have six. But the mantis shrimp has 12 different types of photoreceptors in their eyes – and scientists haven't understood why until now. Jan 27, 2014

Study Offers Insights into Unique Color Vision of Mantis Shrimp...

Why is this so fast?

```
int hash(string key);  
```

* Learn more in CS106B