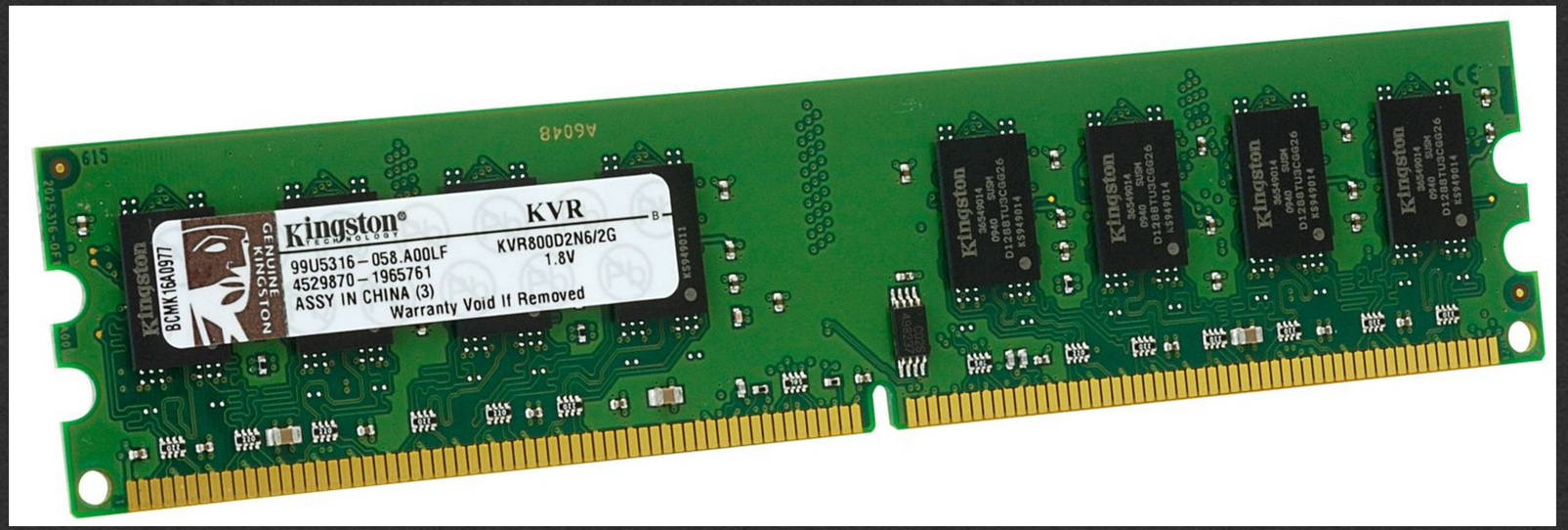
Java

ArrayList, HashMap

Memory

Let's Talk About Memory

- Random Access Memory (RAM)
  - Access any value by index
  - Effectively, a giant array
- All values in your program are stored here



Let's Talk About Memory

- Operating System (OS) controls memory
- On program start, OS allocates a section of memory for our program
  - Gives access to a range of memory addresses/indices

Stack Memory
...
<Used by another program>
<Our Program Memory>
<Our Program Memory>
<Our Program Memory>
<Our Program Memory>
<Our Program Memory>
<Our Program Memory>
<Our Program Memory>
<Our Program Memory>
<Our Program Memory>
<Our Program Memory>
<Our Program Memory>
<Our Program Memory>
<Used by another program>
...

Stack Memory

- Fixed section of memory used to store variables and stack frames
- One continuous section of RAM

- LIFO - Last In First Out
  - New values are added to the end of the stack
  - Only frames at the end of the stack can be removed

Heap Memory

- ArrayLists and HashMaps will be stored in heap memory

- Heap memory is dynamic
  - We can "ask" the OS/JVM for more heap space as needed
- Heap memory can be anywhere in RAM
  - Location is not important
  - Location can change
- Use **references** to find data
  - **Variables only store references to values in the heap**

ArrayList

Java - ArrayList

```java
package week2;

import java.util.ArrayList;

public class ArrayList1 {
    public static int sum(ArrayList<Integer> arrIn) {
        int out = 0;
        for (int x=0; x<arrIn.size(); x++) {
            out += arrIn.get(x);
        }
        return out;
    }

    public static void main(String[] args) {
        ArrayList<Integer> arr1 = new ArrayList<>();
        for (int x=0; x<4; x++) {
            arr1.add(10-x);
        }
        System.out.println(arr1);
        ArrayList<Integer> arr2 = arr1;
        System.out.println(arr2);
        int total = sum(arr1);
        System.out.println("total: " + total);
    }
}
```

- Similar to:
  - List in Python
  - Array in JavaScript
- Sequential data structure
  - Order matters
- Values indexed starting at 0

Java - ArrayList

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        ArrayList<Integer> arr2 = arr1;
        System.out.println(arr2);
        int total = sum(arr1);
        System.out.println("total: " + total);
    }
}
```

- ArrayList is built-in with Java
- However, it is not automatically available
  - Unlike String, int, double, etc.

- Must import ArrayList
  - The ArrayList class is in the java.util package
  - Importing makes the class available in your code

Java - ArrayList

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    }
}
```

- Use the "new" keyword to create a new ArrayList
- Must have <> which is a type parameter list
  - Can also have <Integer> in this example
- Must have () which is an empty argument list
- This calls the classes *constructor* method and returns an *object*
  - Much more detail to come in week 4

Java - ArrayList

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        System.out.println("total: " + total);
    }
}
```

- An ArrayList variable should have a type parameter in <>
- This ArrayList has a type parameter of Integer
  - We say this is an "ArrayList of Integers"
- This ArrayList can **only ever** store Integers

Java - ArrayList

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    public static int sum(ArrayList<Integer> arrIn) {
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        System.out.println(arr2);
        int total = sum(arr1);
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    }
}
```

- The type parameter has to be a class
- Class types start with capital letters
  - You cannot create an ArrayList of ints

Java - ArrayList

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```

- int ≈ Integer
- double ≈ Double
- boolean ≈ Boolean
- Use the class equivalents for our primitive (starts with lowercase letter) types
  - [In most cases] Java will automatically convert between the two
  - Conversion is called auto-boxing
- We'll always use the primitive types unless we must use the class equivalent

Java - ArrayList

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}
```
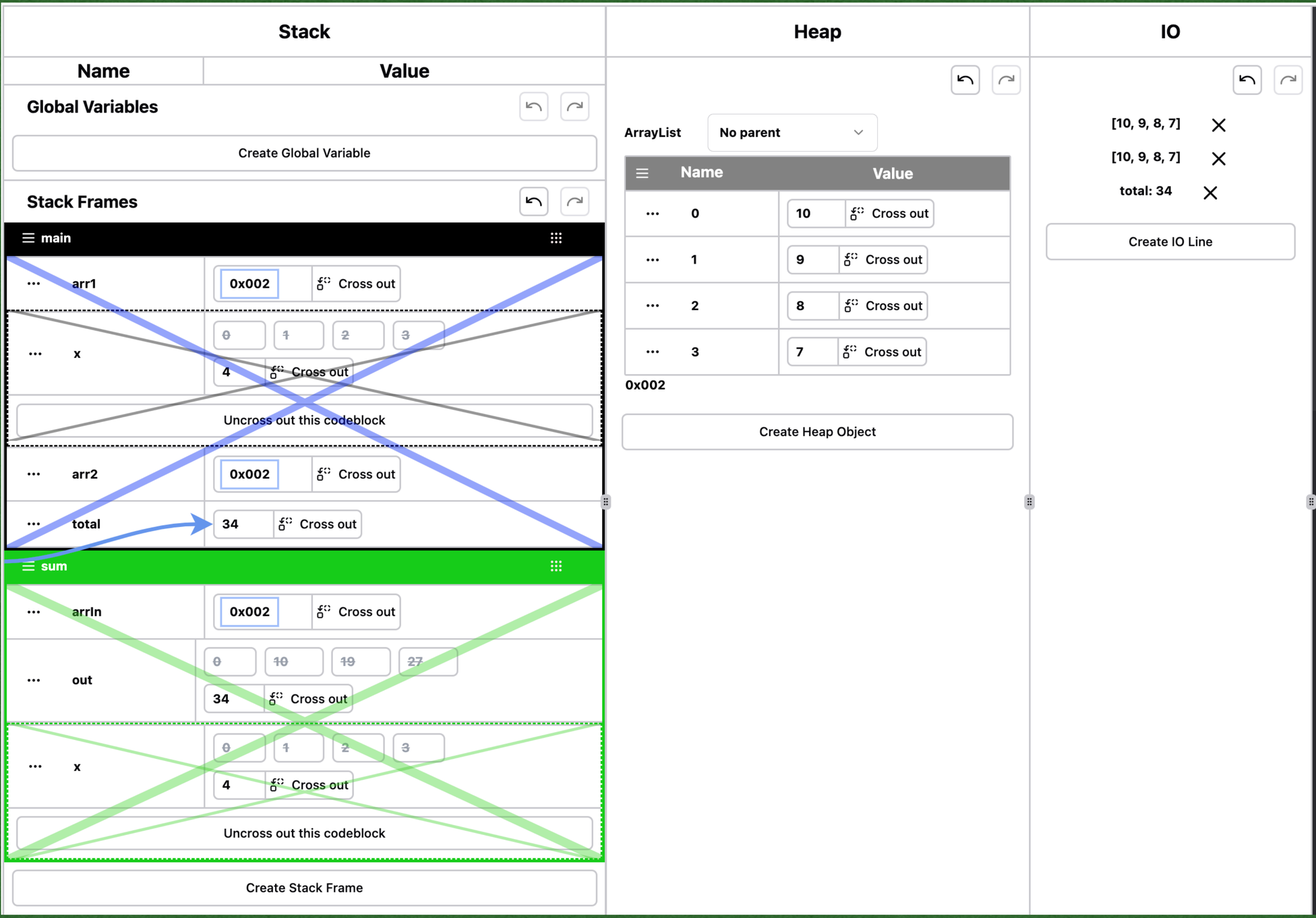

- Call the add method to insert a value at the end of the ArrayList
- Call get with an index to retrieve that value at that index
  - **Cannot** use [index] to access a value in an ArrayList

Memory Diagram

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        System.out.println(arr2);
        int total = sum(arr1);
        System.out.println("total: " + total);
    }
}
```

Stack

Name	Value

Heap

in/out

- It all starts the same
- It will quickly become very different

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import java.util.ArrayList;

public class ArrayList1 {
    public static int sum(ArrayList<Integer> arrIn) {
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        int total = sum(arr1);
        System.out.println("total: " + total);
    }
}
```

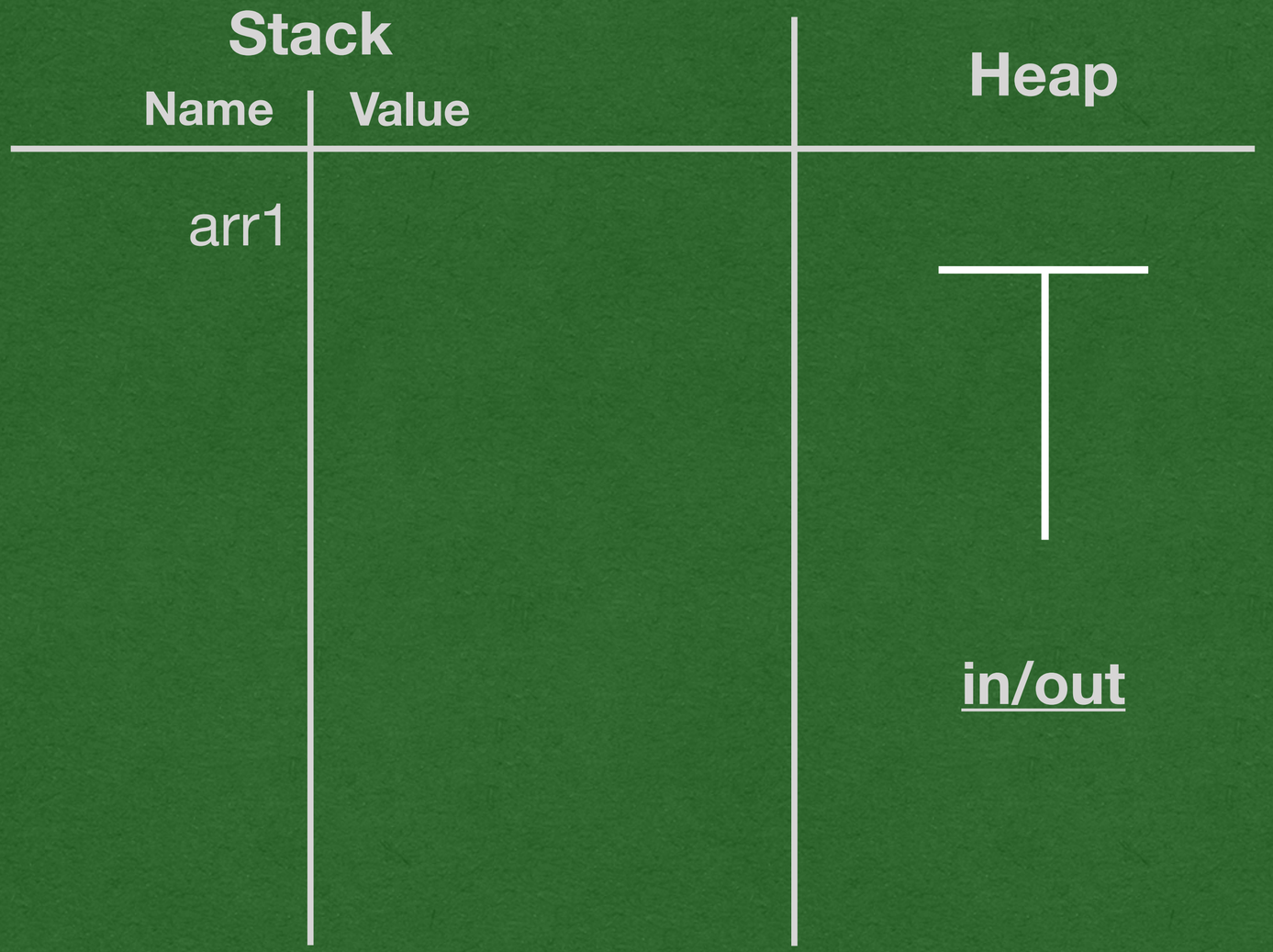

- We create an ArrayList
- ArrayLists go in the heap!

```java
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import java.util.ArrayList;

public class ArrayList1 {
    public static int sum(ArrayList<Integer> arrIn) {
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            out += arrIn.get(x);
        }
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        ArrayList<Integer> arr2 = arr1;
        System.out.println(arr2);
        int total = sum(arr1);
        System.out.println("total: " + total);
    }
}
```

Stack

Name	Value
arr1	

Heap

in/out

- When an ArrayList is created on the heap:
  - Create 2 columns: One for indices, one for values

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            out += arrIn.get(x);
        }
        return out;
    }

    public static void main(String[] args) {
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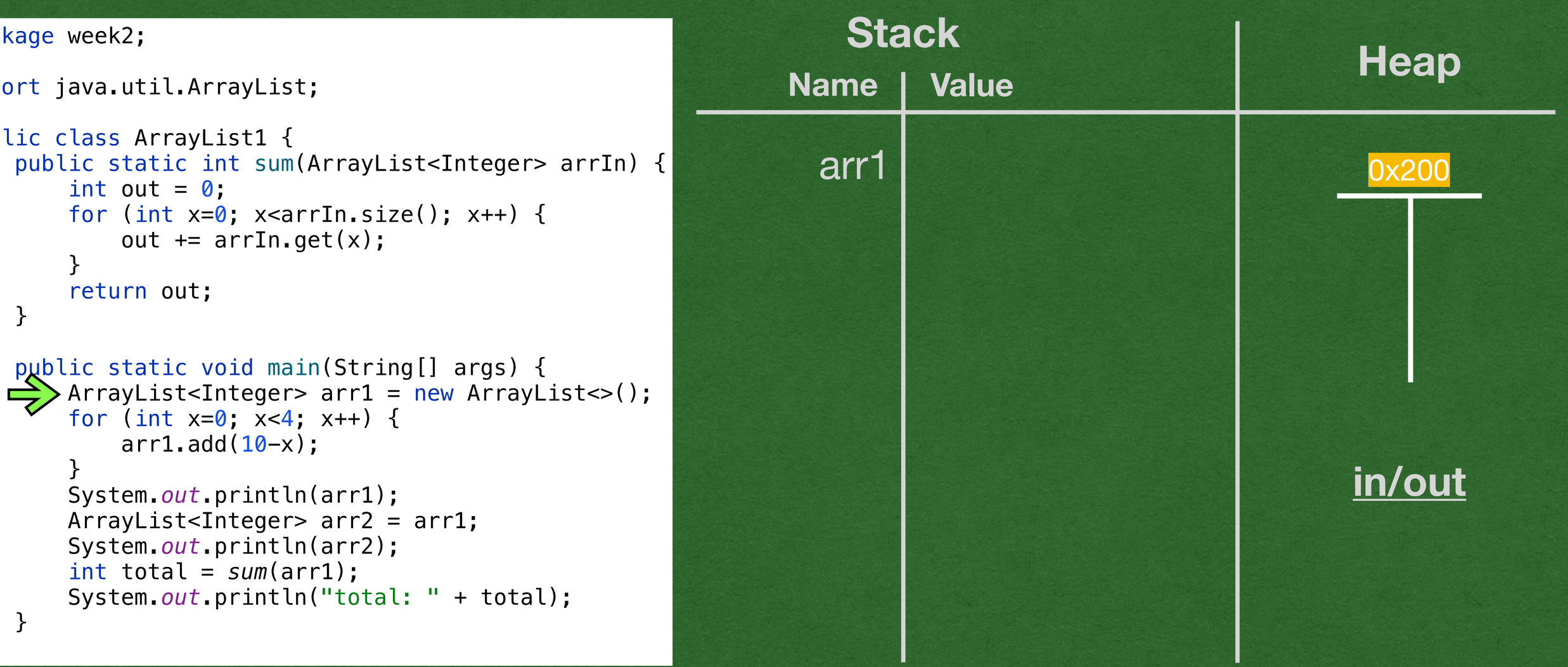
            arr1.add(10-x);
        }
        System.out.println(arr1);
        ArrayList<Integer> arr2 = arr1;
        System.out.println(arr2);
        int total = sum(arr1);
        System.out.println("total: " + total);
    }
}
```



- Value on the heap always get a memory address
  - "0x" followed by a number (You can choose any numbers for your diagrams)
  - This tells java where in memory it can find the value

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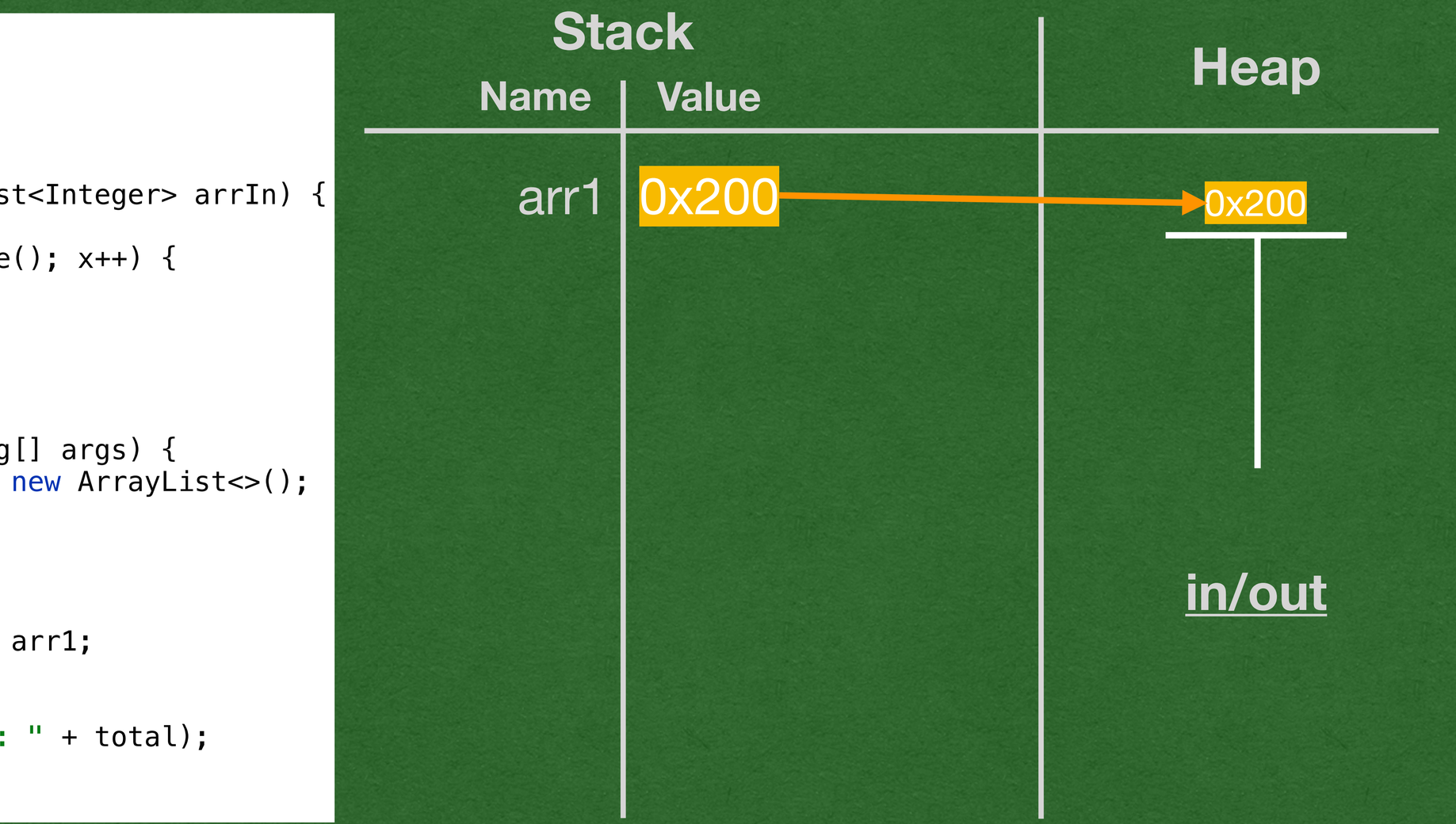

- When a variable "stores" a value that's on the heap, it only store a **reference** to that value
- arr1 only stores instructors of how to find the ArrayList in the heap

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public class ArrayList1 {
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        int out = 0;
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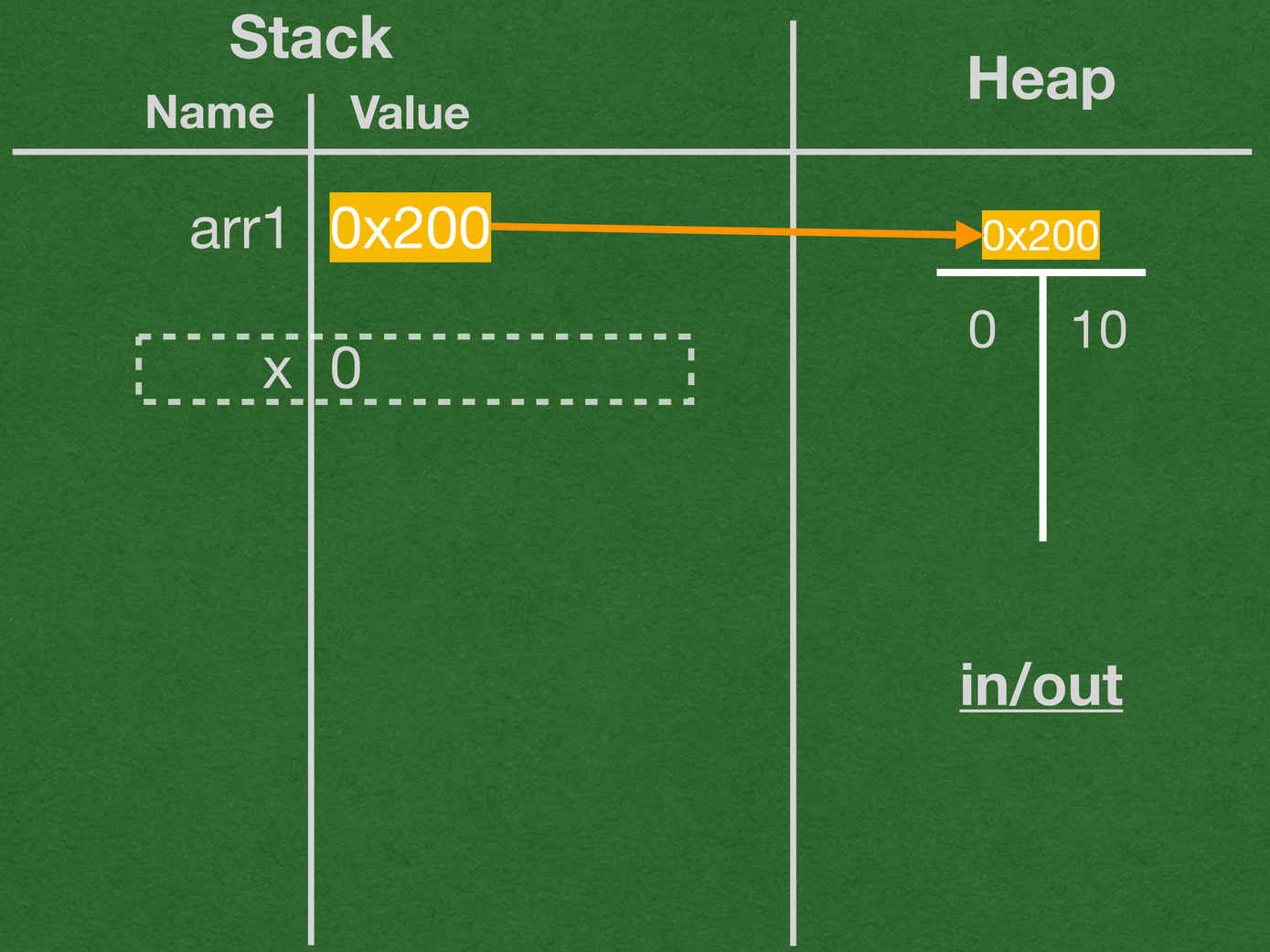

- Each time we add a value to an ArrayList, it is added to the next index

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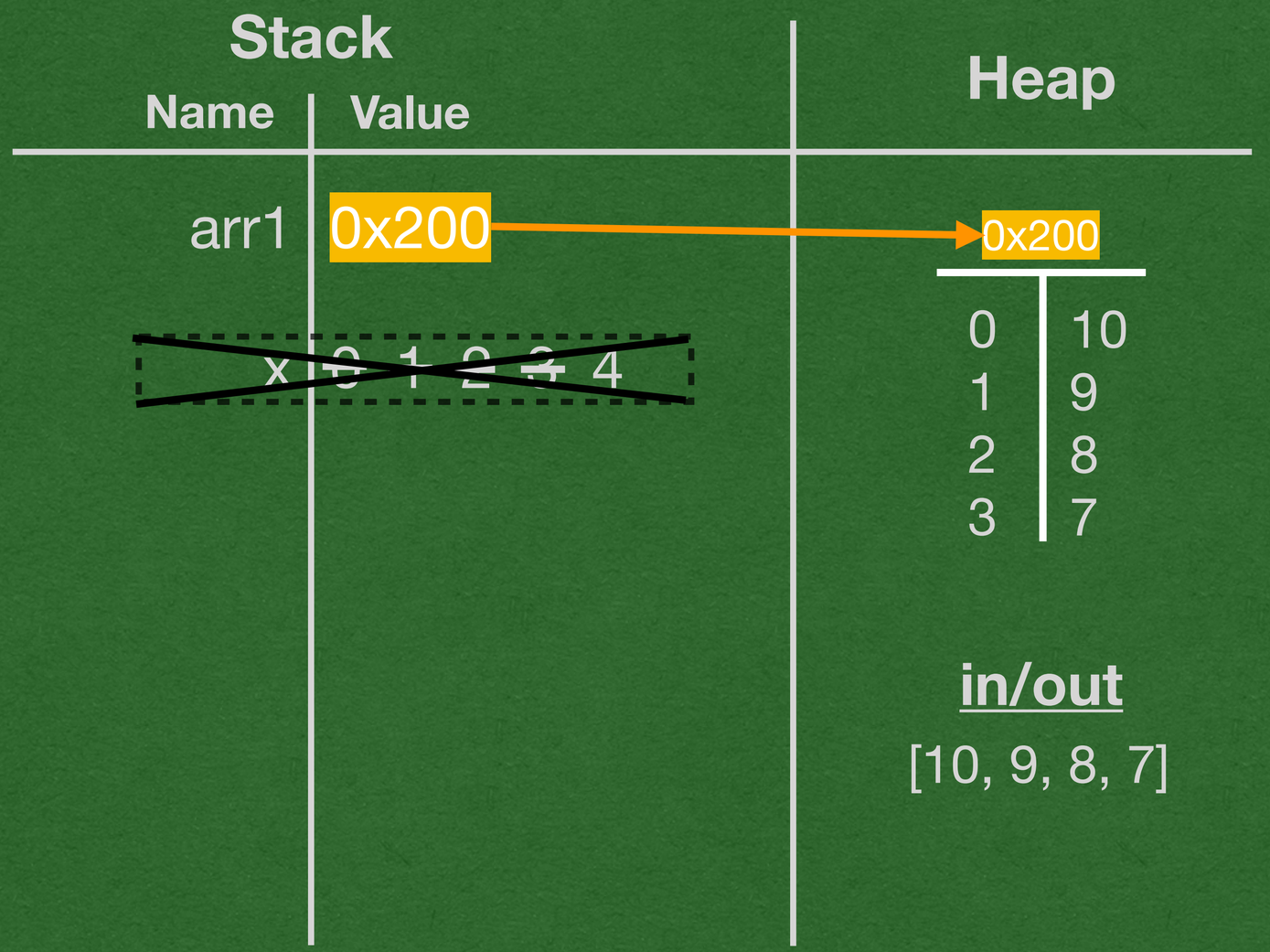

- Printing an ArrayList will print all it's values in [ ] separated by commas

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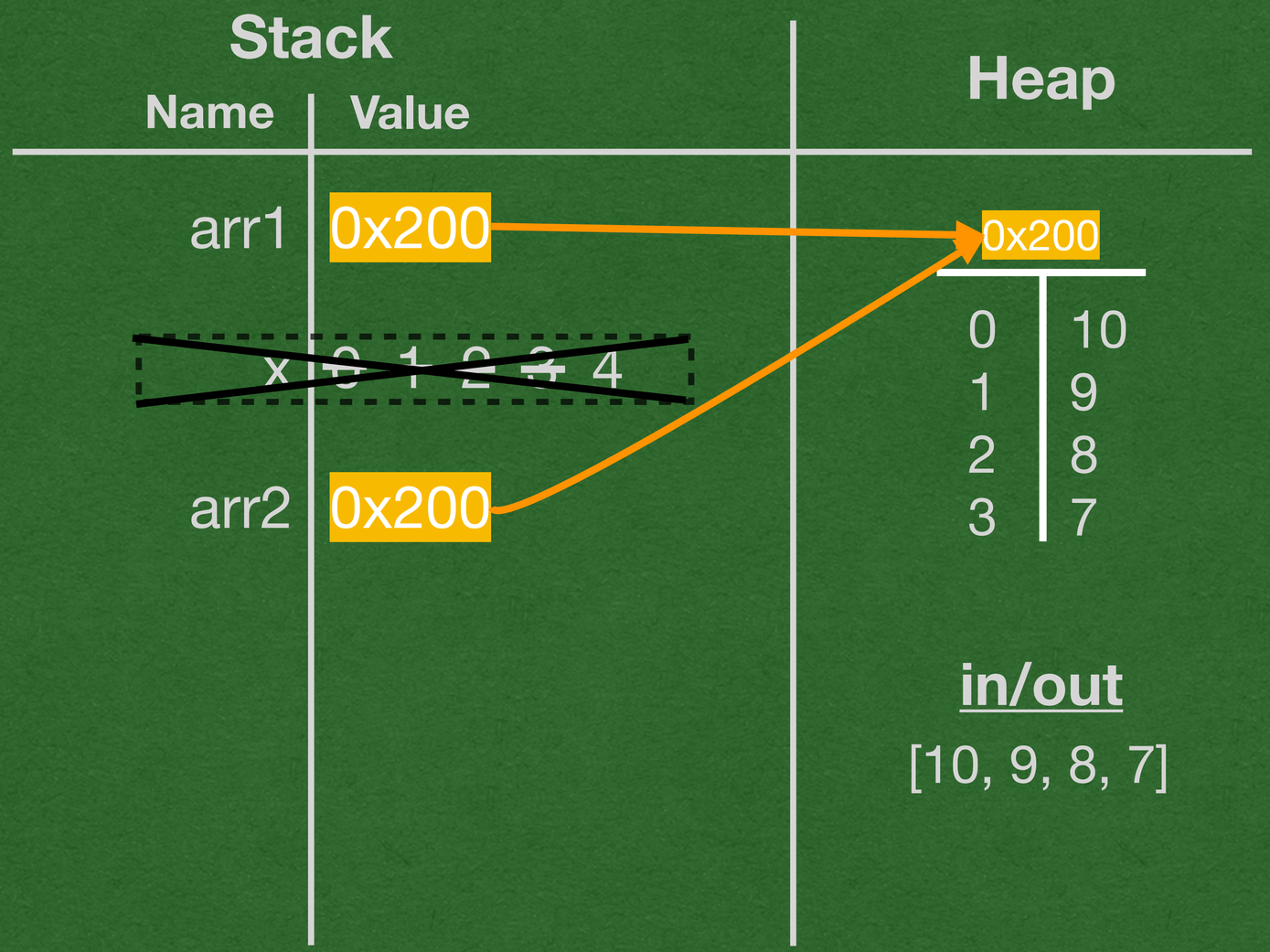

- When a variable is assigned a value that is a reference, **only** the **reference** is assigned!
- There is no copy of the ArrayList created. Only 1 ArrayList exists in memory
  - That ArrayList is *referred to* by the 2 variables that store its reference

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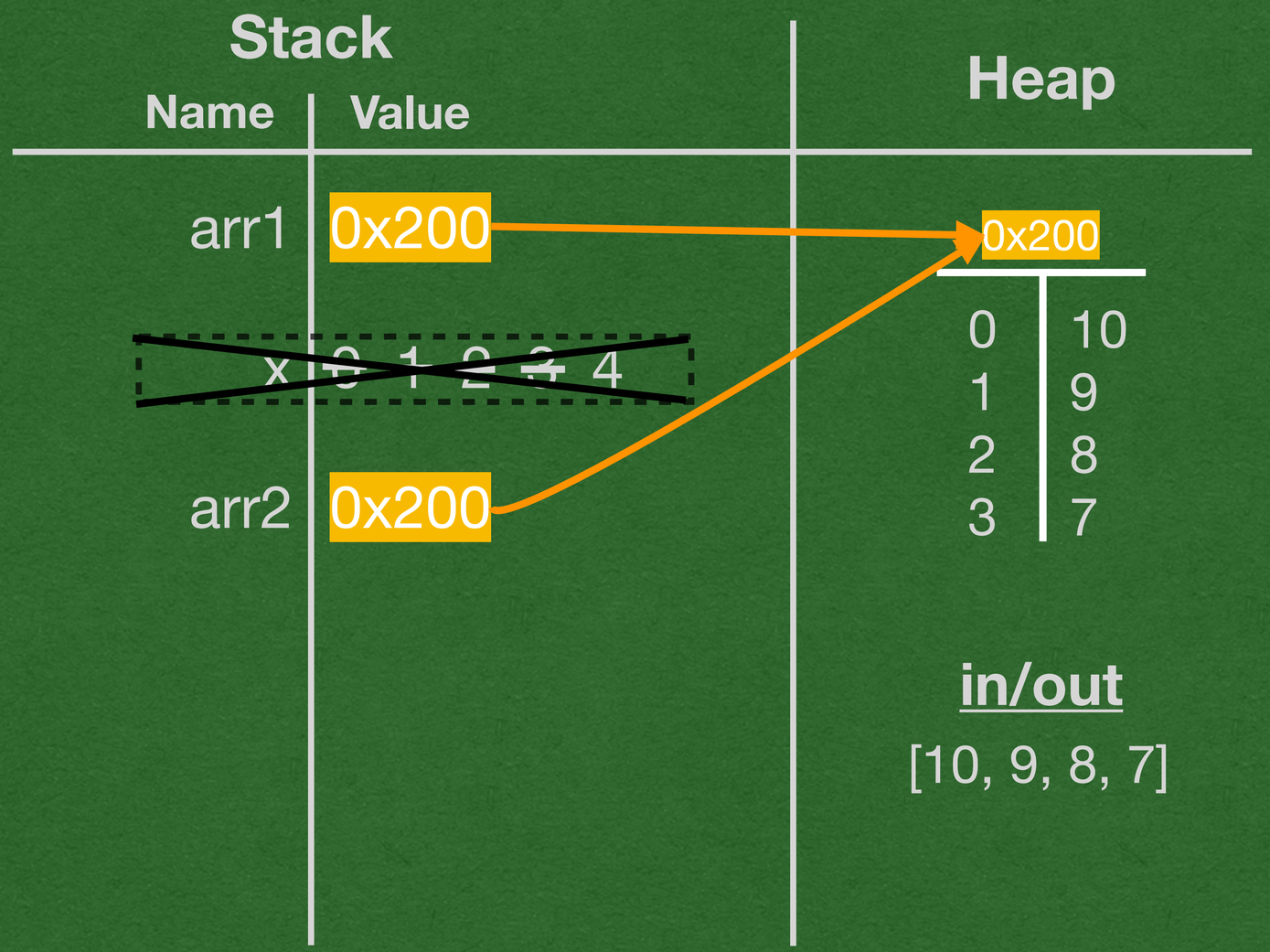

- This is **assign-by-reference**
- Only the reference is assigned

Technically it's assign-by-value, but the value is a reference

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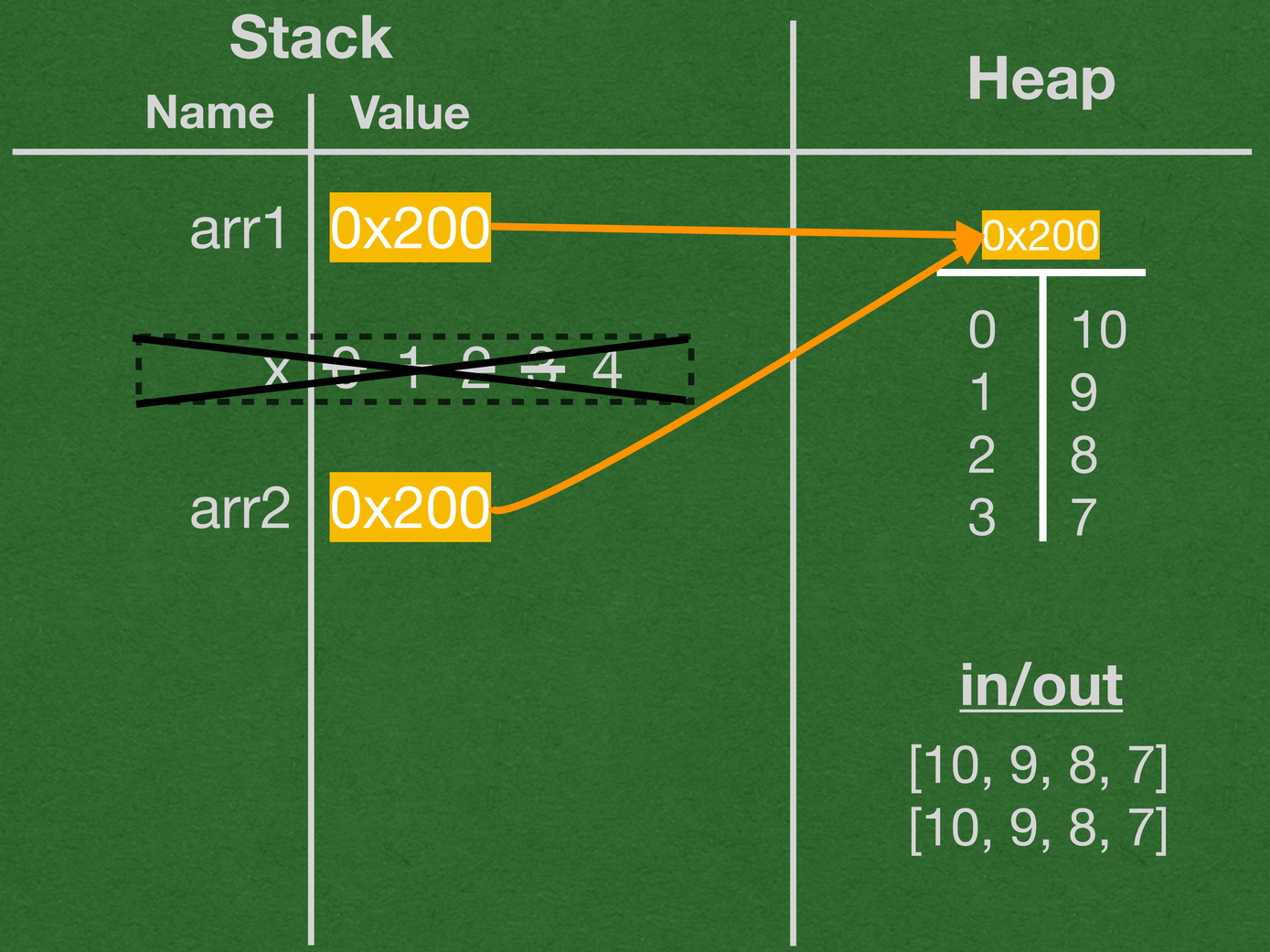

- arr2 refers to the same ArrayList as arr1 -- the only ArrayList in this example
- Printing arr2 is the same as printing arr1

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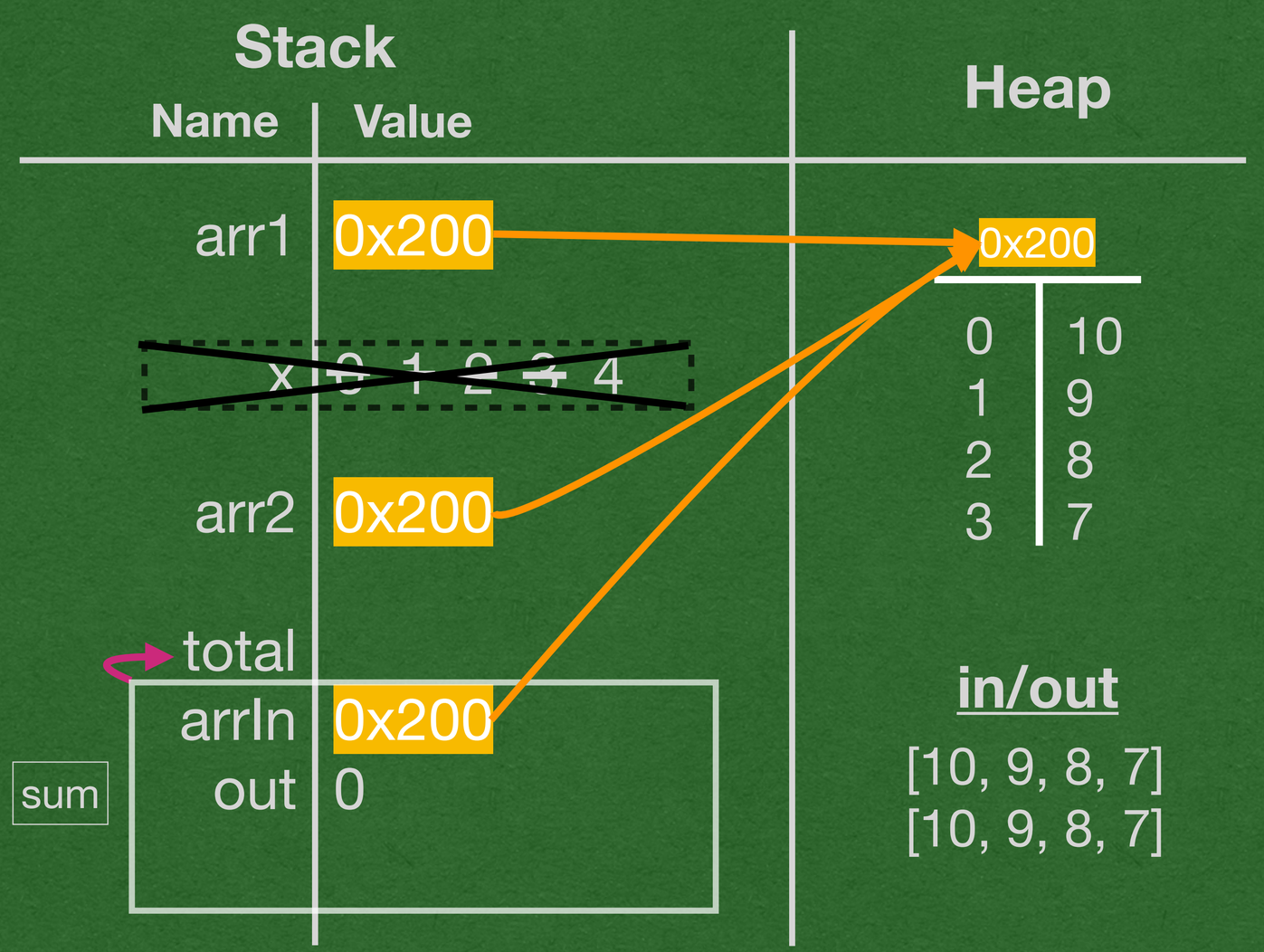

- When a method is called that take an object on the heap as a parameter, only the reference is passed into the stack frame
- This is **pass-by-reference**

Technically it's pass-by-value, but the value passed is a reference

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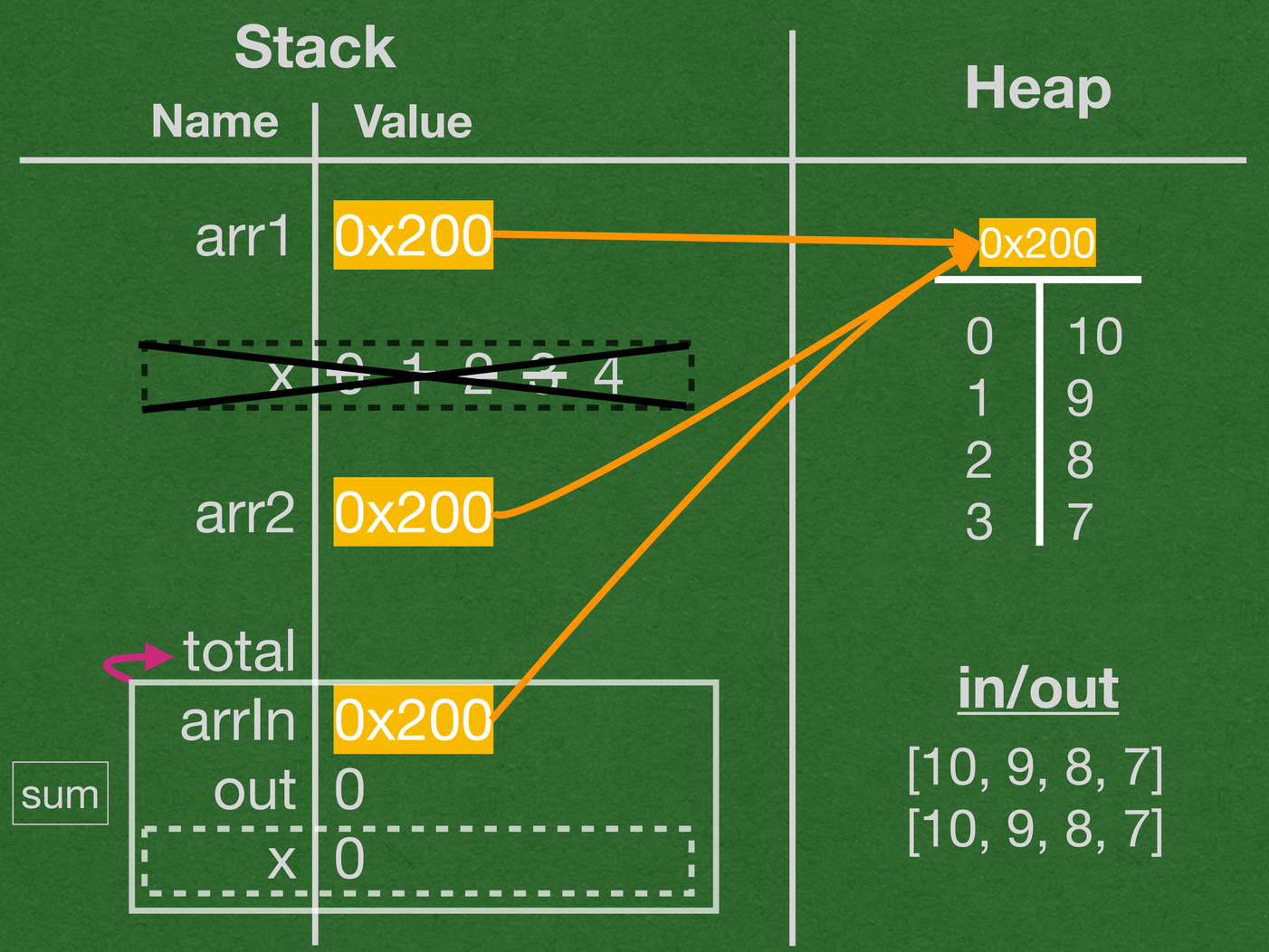

- When using the reference, the dot operator . means we follow the reference to the object to which it refers
- arrIn.size() means - go to the ArrayList referred to by this reference and call it's size method

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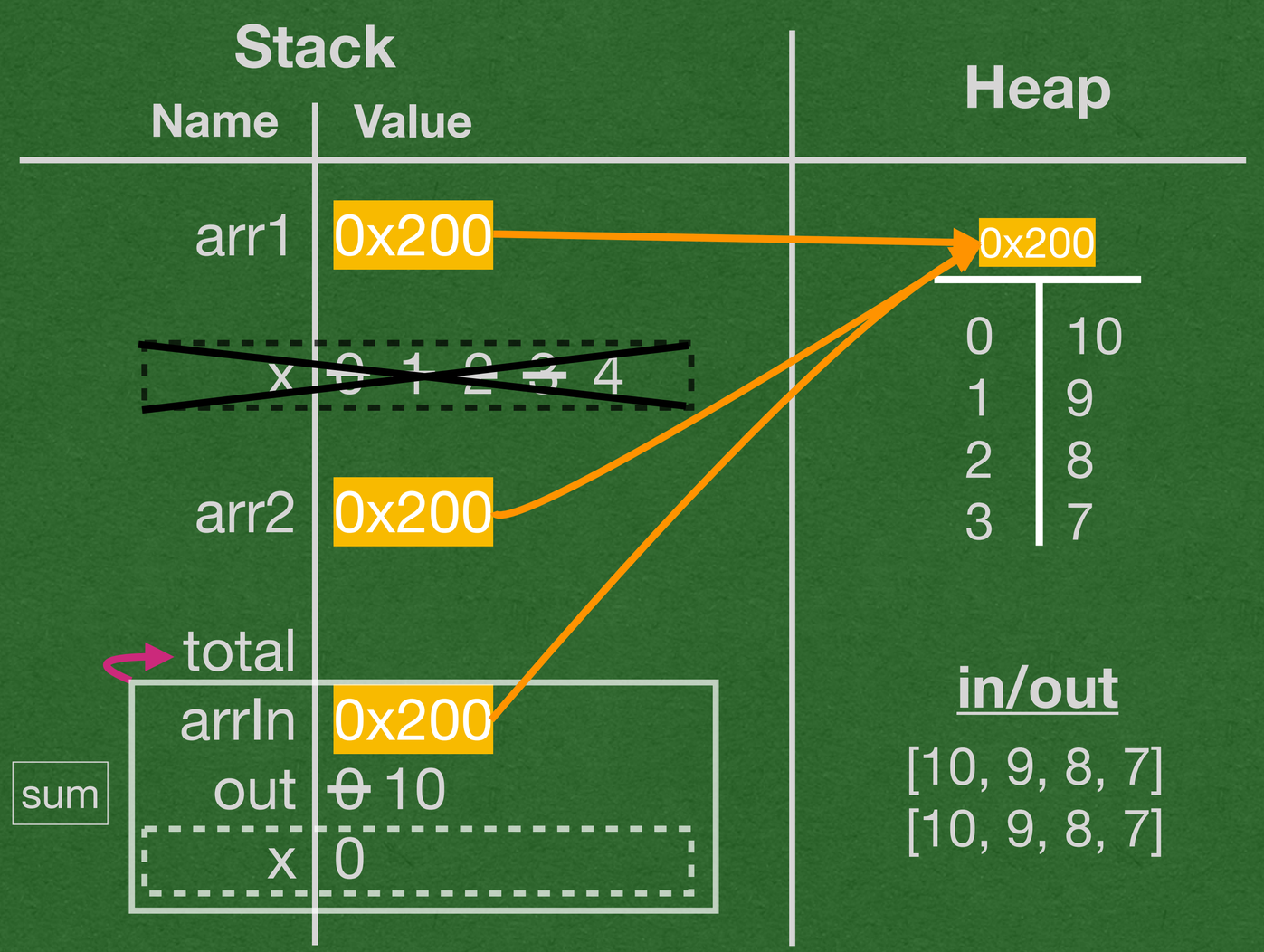

- arrIn.get(x)
  - Follow the reference
  - Return the value stored at index x and add 10 to the out variable

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        }
        System.out.println(arr1);
        ArrayList<Integer> arr2 = arr1;
        System.out.println(arr2);
        int total = sum(arr1);
        System.out.println("total: " + total);
    }
}
```
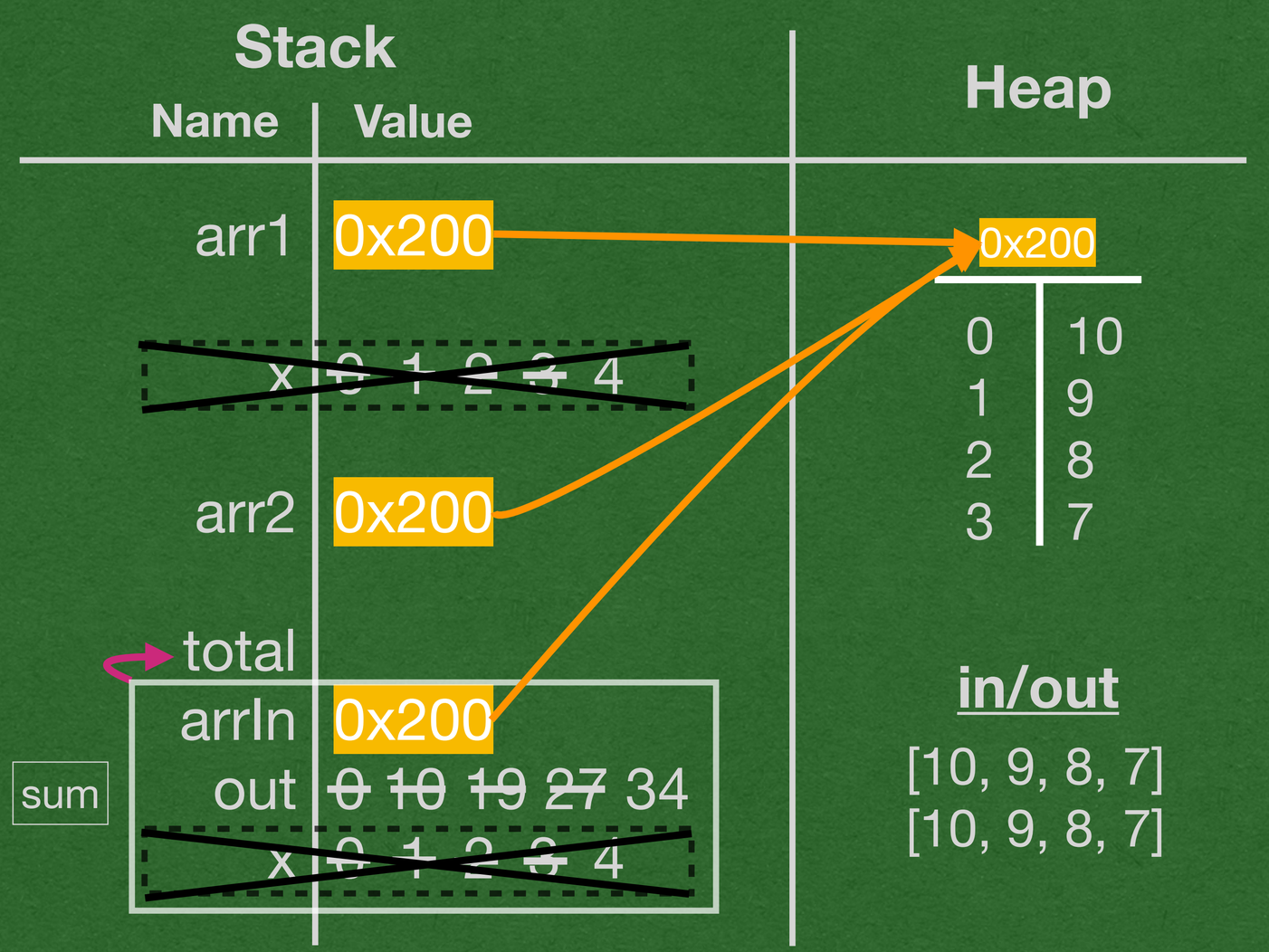
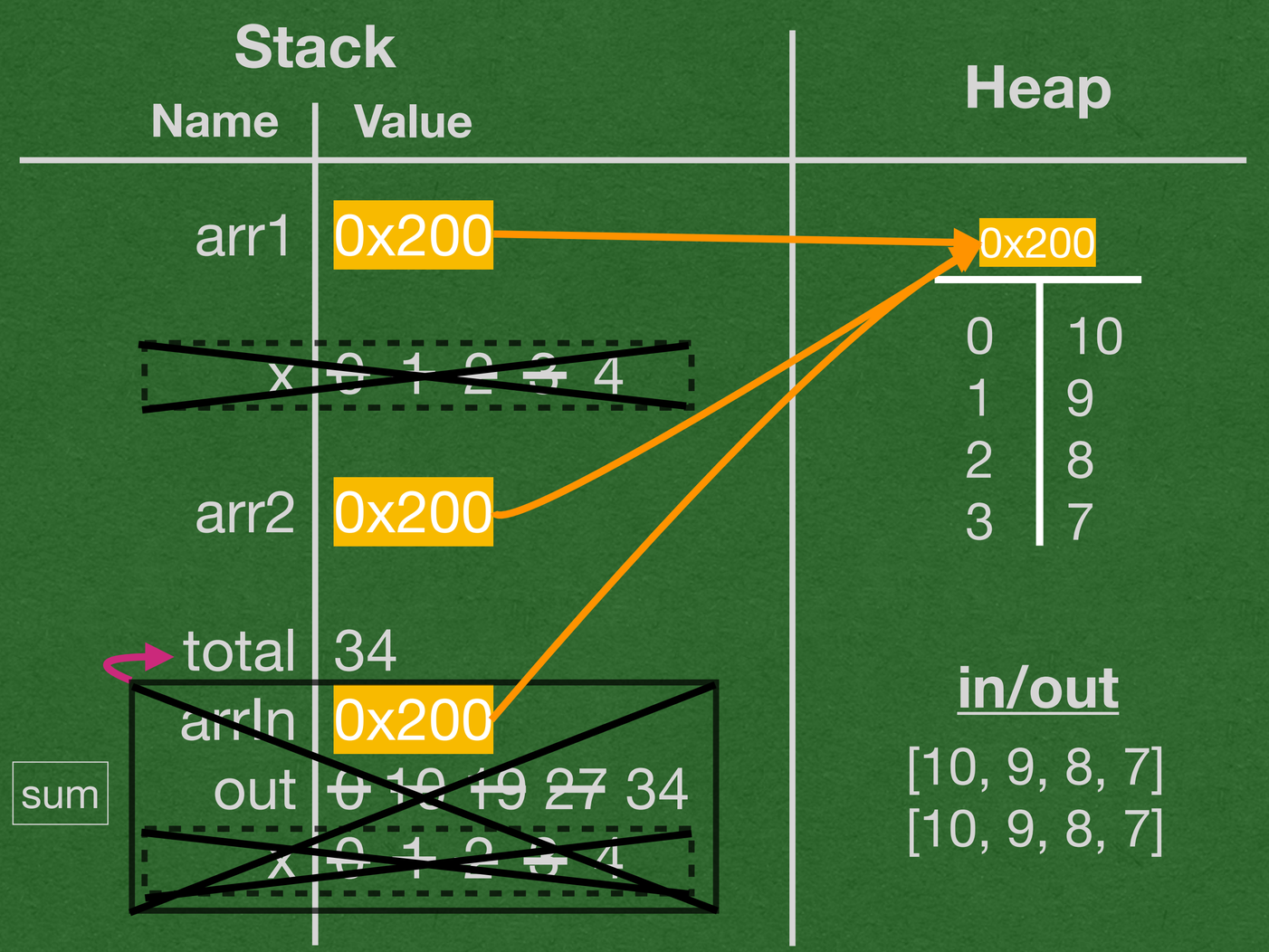



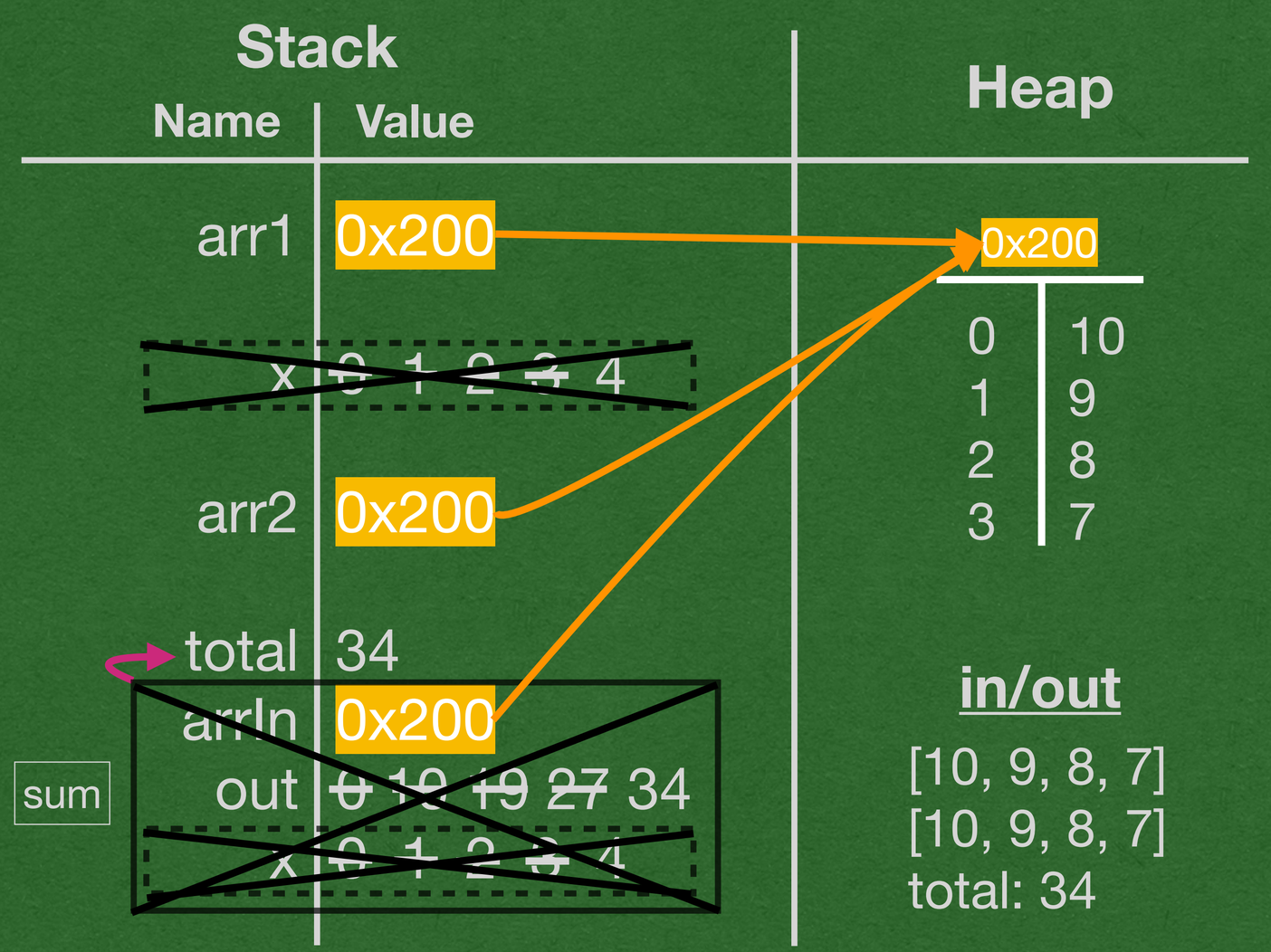
- When x is 4, x<arrIn.size() is false
- The loop ends and x is removed from memory

```java
package week2;

import java.util.ArrayList;

public class ArrayList1 {
    public static int sum(ArrayList<Integer> arrIn) {
        int out = 0;
        for (int x=0; x<arrIn.size(); x++) {
            out += arrIn.get(x);
        }
        return out;
    }

    public static void main(String[] args) {
        ArrayList<Integer> arr1 = new ArrayList<>();
        for (int x=0; x<4; x++) {
            arr1.add(10-x);
        }
        System.out.println(arr1);
        ArrayList<Integer> arr2 = arr1;
        System.out.println(arr2);
        int total = sum(arr1);
        System.out.println("total: " + total);
    }
}
```

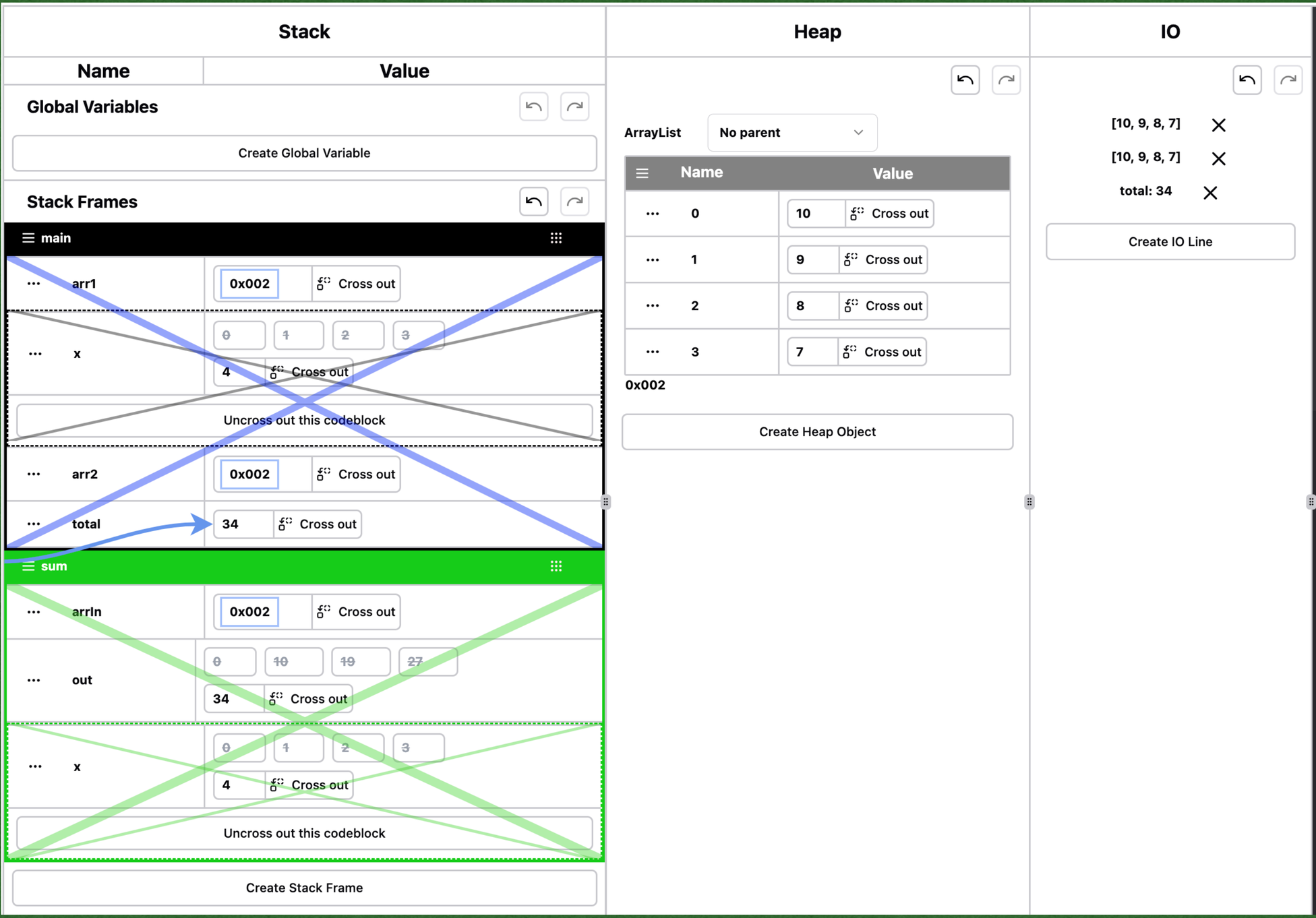


- Return the value of the out variable to the total variable
- The entire stack frame is removed from memory

```java
package week2;

import java.util.ArrayList;

public class ArrayList1 {
    public static int sum(ArrayList<Integer> arrIn) {
        int out = 0;
        for (int x=0; x<arrIn.size(); x++) {
            out += arrIn.get(x);
        }
        return out;
    }

    public static void main(String[] args) {
        ArrayList<Integer> arr1 = new ArrayList<>();
        for (int x=0; x<4; x++) {
            arr1.add(10-x);
        }
        System.out.println(arr1);
        ArrayList<Integer> arr2 = arr1;
        System.out.println(arr2);
        int total = sum(arr1);
        System.out.println("total: " + total);
    }
}
```



- Print total
- End of program




```java
package week2;

import java.util.ArrayList;

public class ArrayList1 {
    public static int sum(ArrayList<Integer> arrIn) {
        int out = 0;
        for (int x=0; x<arrIn.size(); x++) {
            out += arrIn.get(x);
        }
        return out;
    }

    public static void main(String[] args) {
        ArrayList<Integer> arr1 = new ArrayList<>();
        for (int x=0; x<4; x++) {
            arr1.add(10-x);
        }
        System.out.println(arr1);
        ArrayList<Integer> arr2 = arr1;
        System.out.println(arr2);
        int total = sum(arr1);
        System.out.println("total: " + total);
    }
}
```

HashMap

Java - HashMap

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

- Similar to:
  - Dictionary in Python
  - Object in JavaScript
- Key-Value Store
  - Order does not matter
  - Cannot have duplicate keys
- Used to associate keys with values

Java - HashMap

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

- Must import before use
- Most types we use from here onward need to be imported
- Only primitives and classes in the java.lang package do not need to be imported

Java - HashMap

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

- HashMaps have 2 type parameters
- First is the type of the keys
- Second is the type of the values

- We say this is a:
  - HashMap from String to Integer
  - Maps Strings to Integers

Java - HashMap

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

- Add key-value pairs using "put"
- Retrieve a value at a particular key using "get"

Java - HashMap

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

- for-each loop
  - Or "enhanced" loop in the world of Java
- Very similar to Python loops

for (type variableName : dataStructure)

- Read: for variableName in dataStructure

Doesn't have to be a data structure.
Anything that can be iterated over will work

Java - HashMap

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

- keySet
  - Allows us iterate (loop) over the keys
- values
  - Allows us to iterate over the values
- Common to iterate over the keys and access the values if you need both

Memory Diagram

Stack

Name	Value

Stack Frames

main

bills	0x002	Cross out
key	~~"Allen"~~	
	“Coleman”	Cross out
value	~~17~~	
	0	Cross out
key	~~"Allen"~~	
	“Coleman”	Cross out
value	~~17~~	
	0	Cross out

Uncross out this codeblock

Uncross out this codeblock

Uncross out this codeblock

Create Stack Frame

Heap

HashMap — No parent

Name	Value	
"Allen"	17	Cross out
“Coleman”	0	Cross out

0x002

Create Heap Object

IO

What is Allen's number? 17

{Allen=17, Coleman=0}

Allen

Coleman

17

14

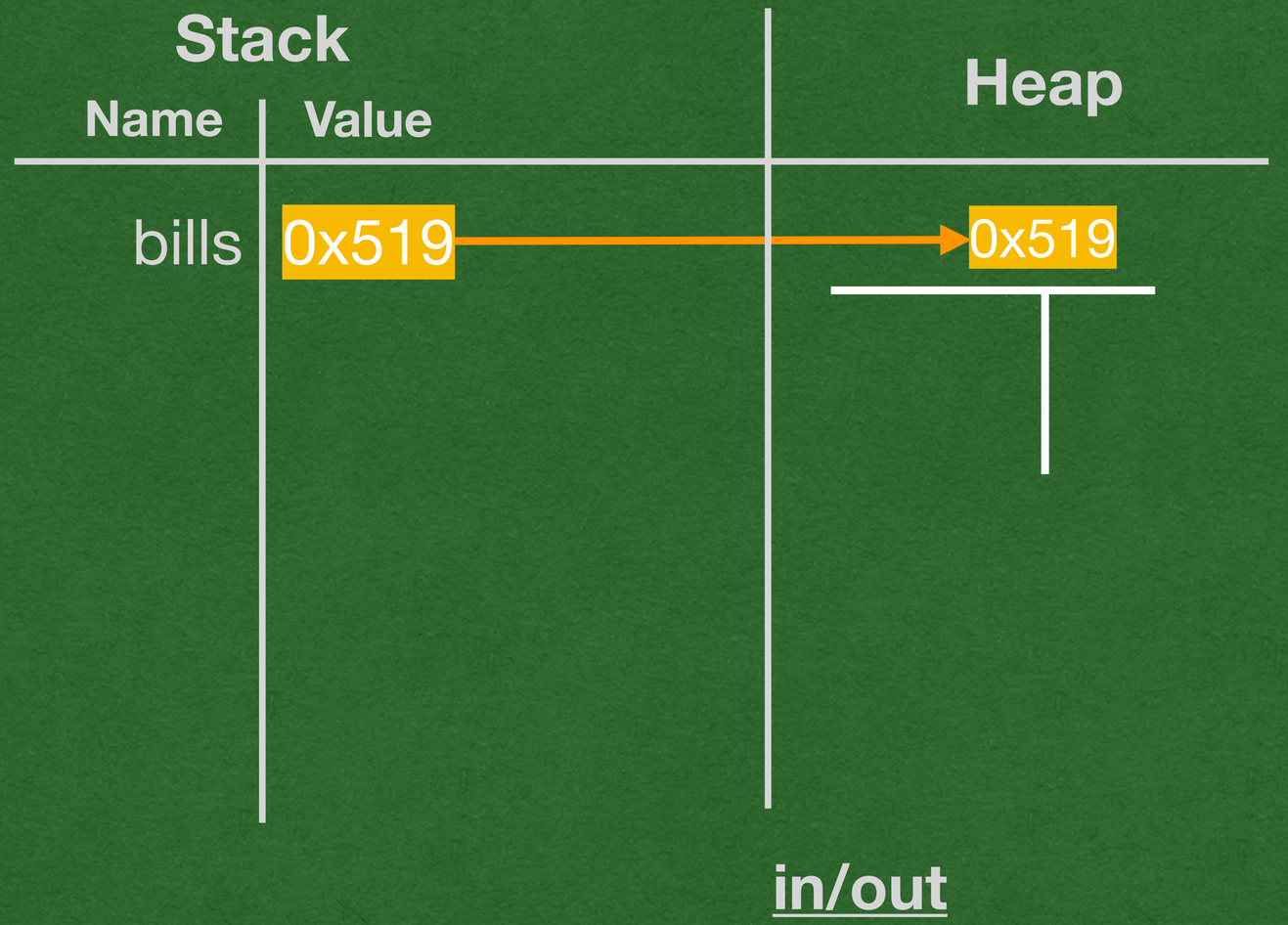
Allen's number is: 17

Coleman 's number is: 0

Create IO Line

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Diggs", 14);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

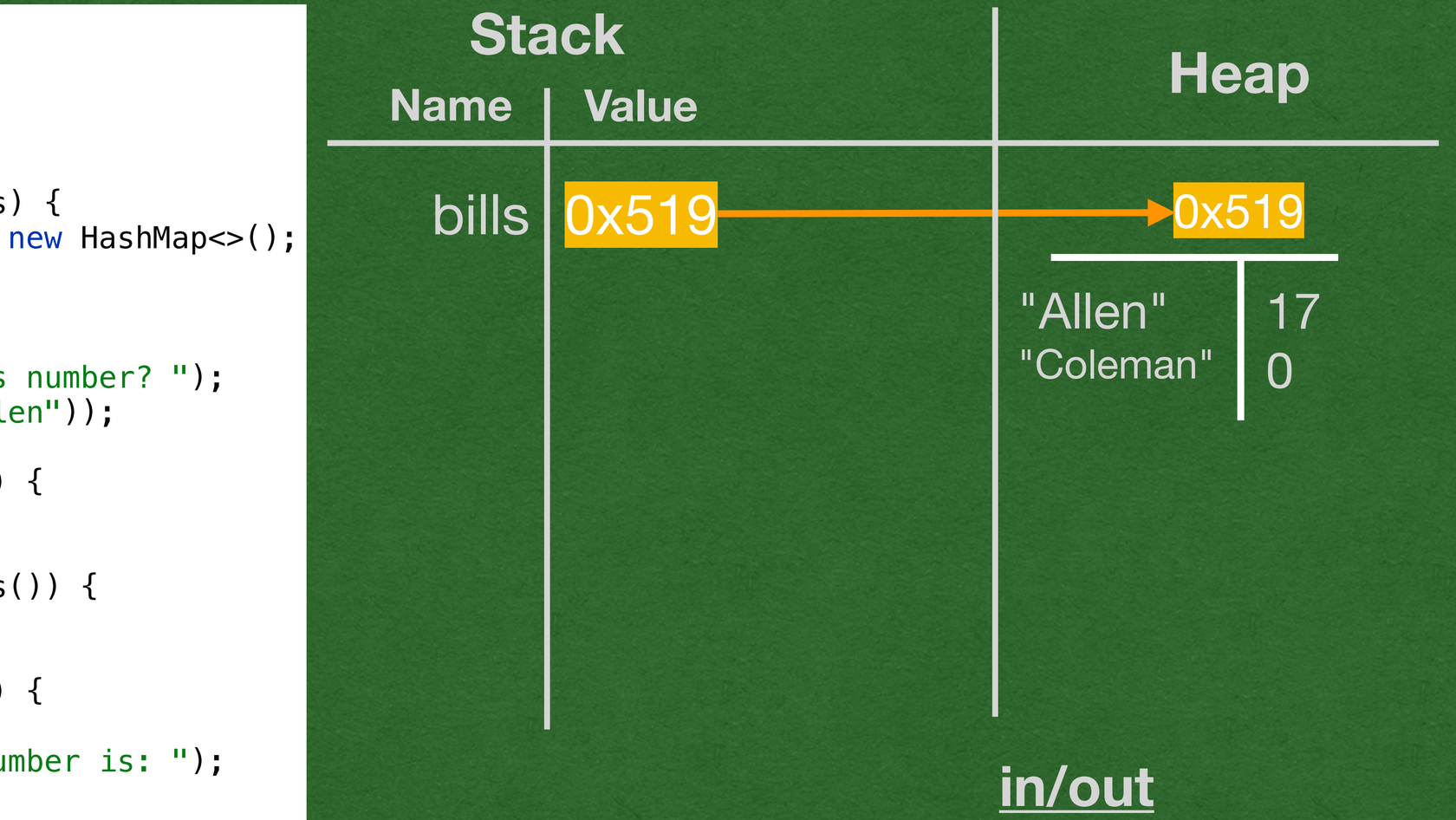
```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```



in/out

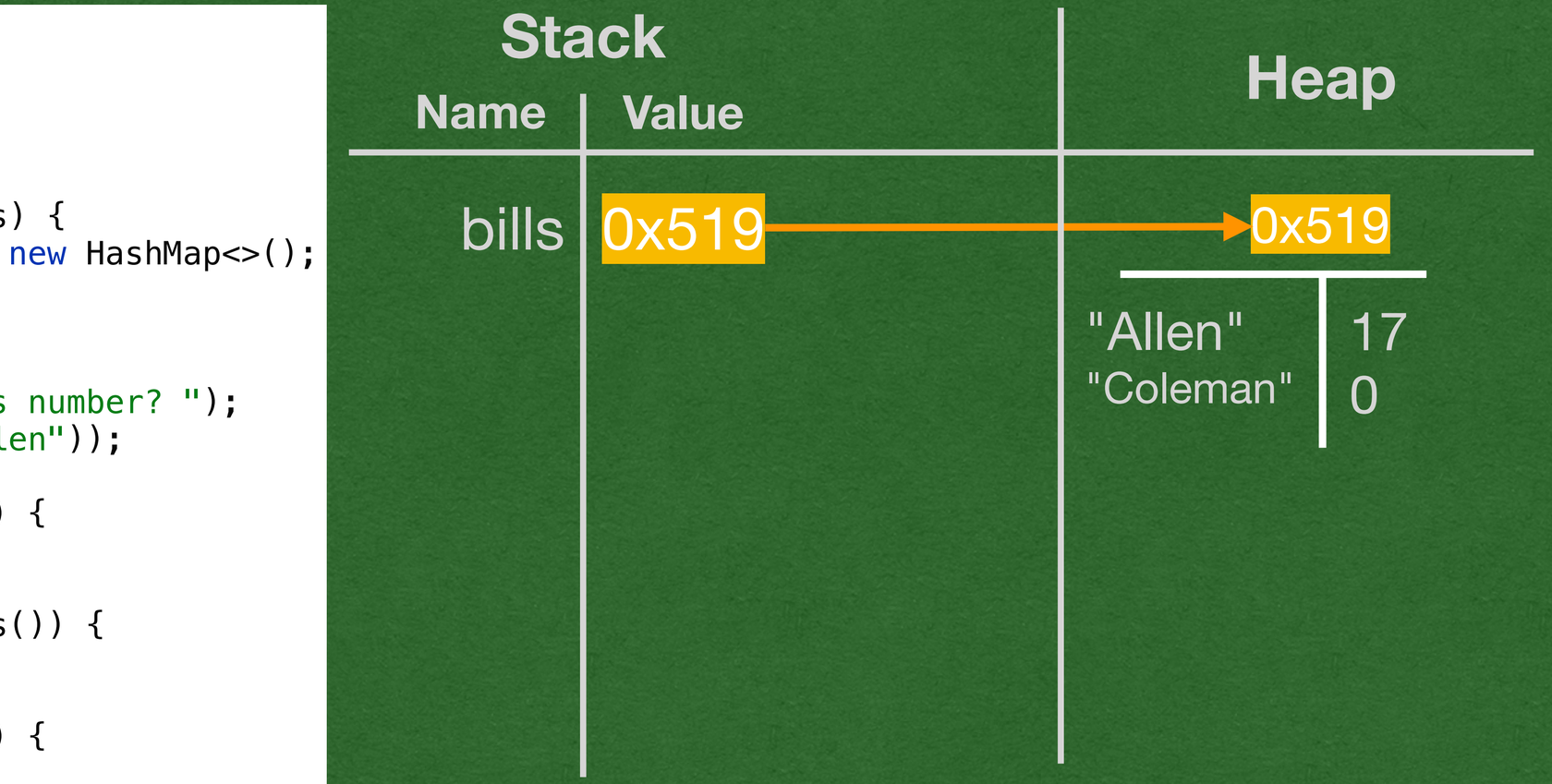
- HashMaps go in the heap
- Only a reference to the HashMap is stored on the stack

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```



- HashMaps have columns for keys and values

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

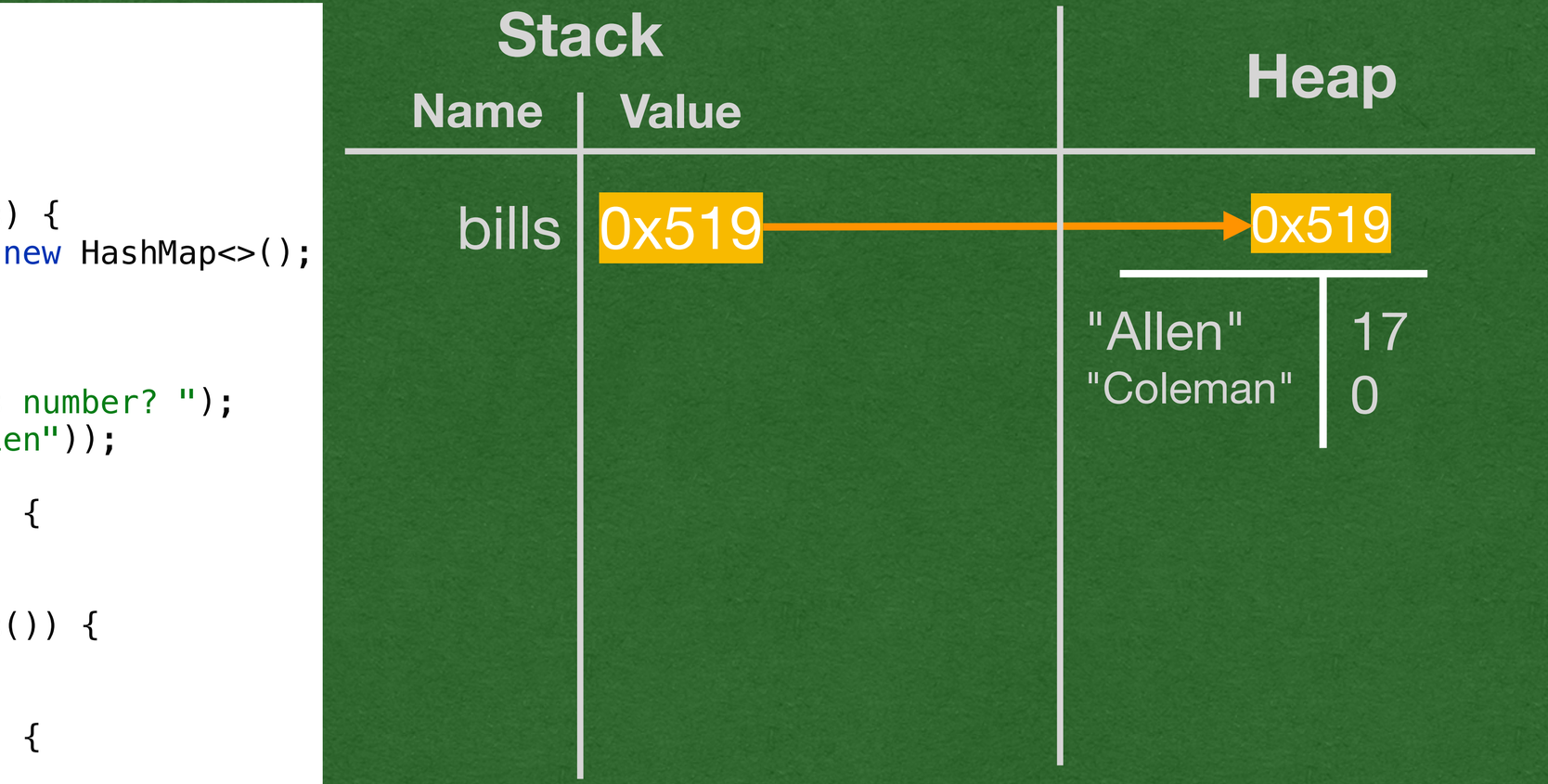


in/out

What is Allen's number? 17
{Coleman=0, Allen=17}

- HashMap prints as a list of key-value pairs in { } separated by commas
- Equal sign = separates each key from it's value

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

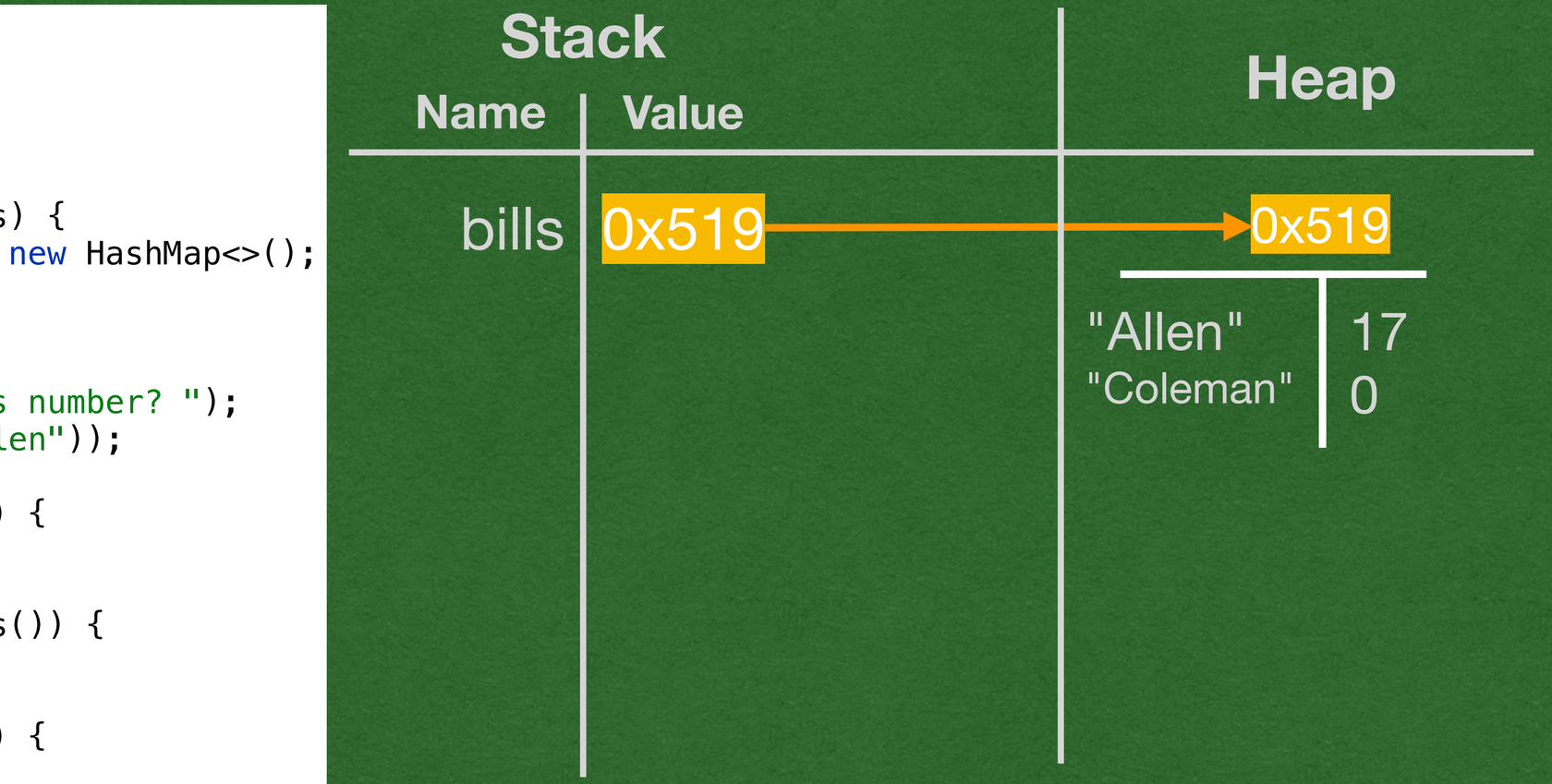


in/out

What is Allen's number? 17
{Coleman=0, Allen=17}

- Order does not matter in a HashMap!
- Notice how “Coleman" was printed before "Allen"
- No simple way to predict the order

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

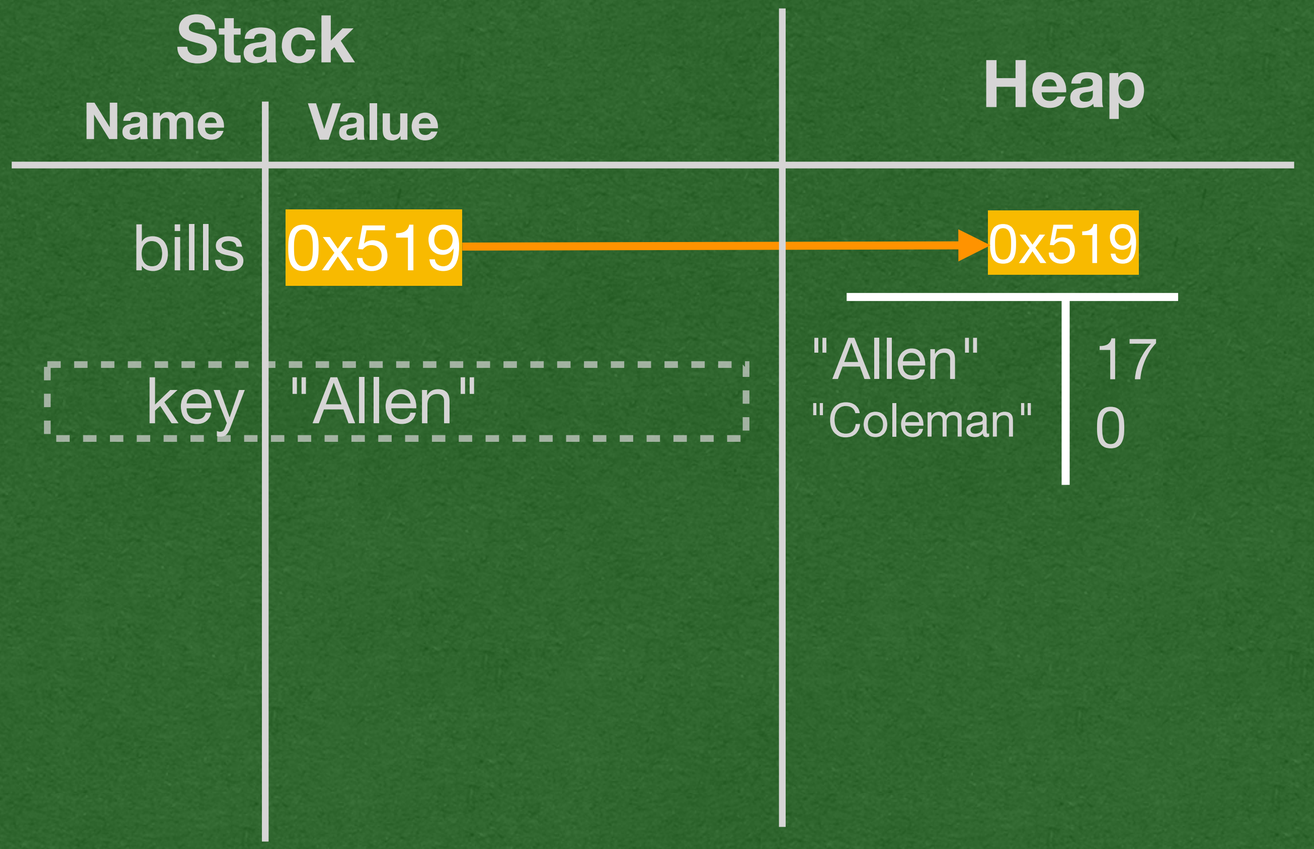


in/out

What is Allen's number? 17
{Coleman=0, Allen=17}

- In your memory diagrams, any order is acceptable for credit

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

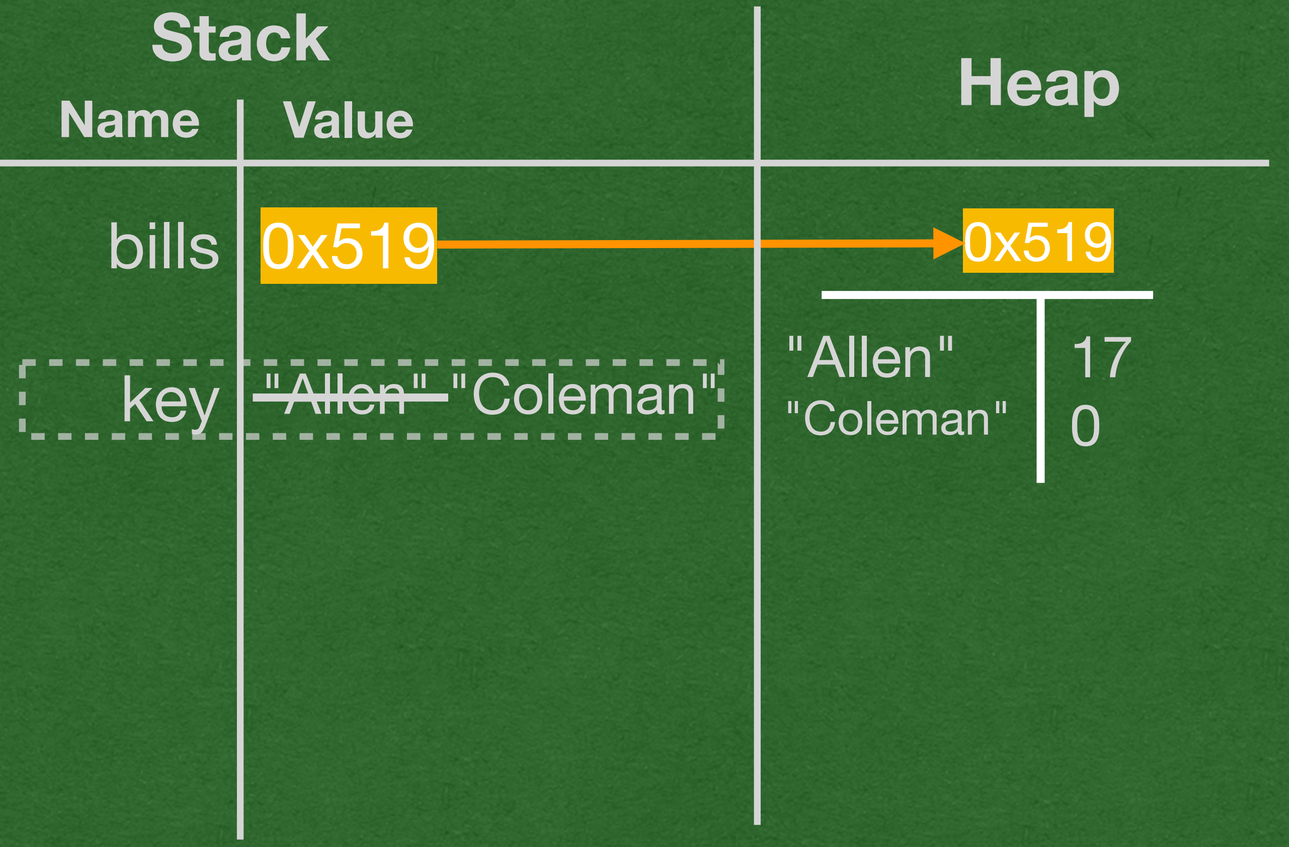


in/out

What is Allen's number? 17
{Coleman=0, Allen=17}
Allen

- Iterating over the keySet stores each key in the "key" variable and runs the body of the loop for each key

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

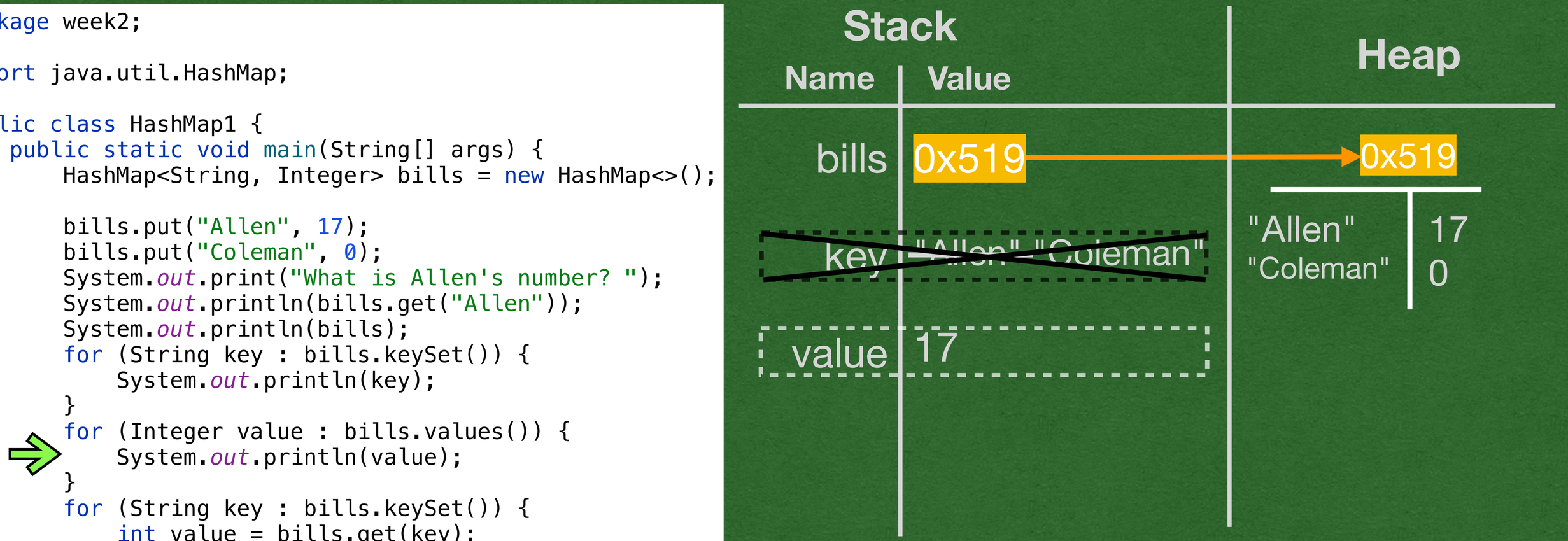


in/out

What is Allen's number? 17
{Coleman=0, Allen=17}
Allen
Coleman

- Once we iterate over all the keys, the loops ends
- Note: If there are no key-value pairs in the HashMap, the loop body will never execute

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

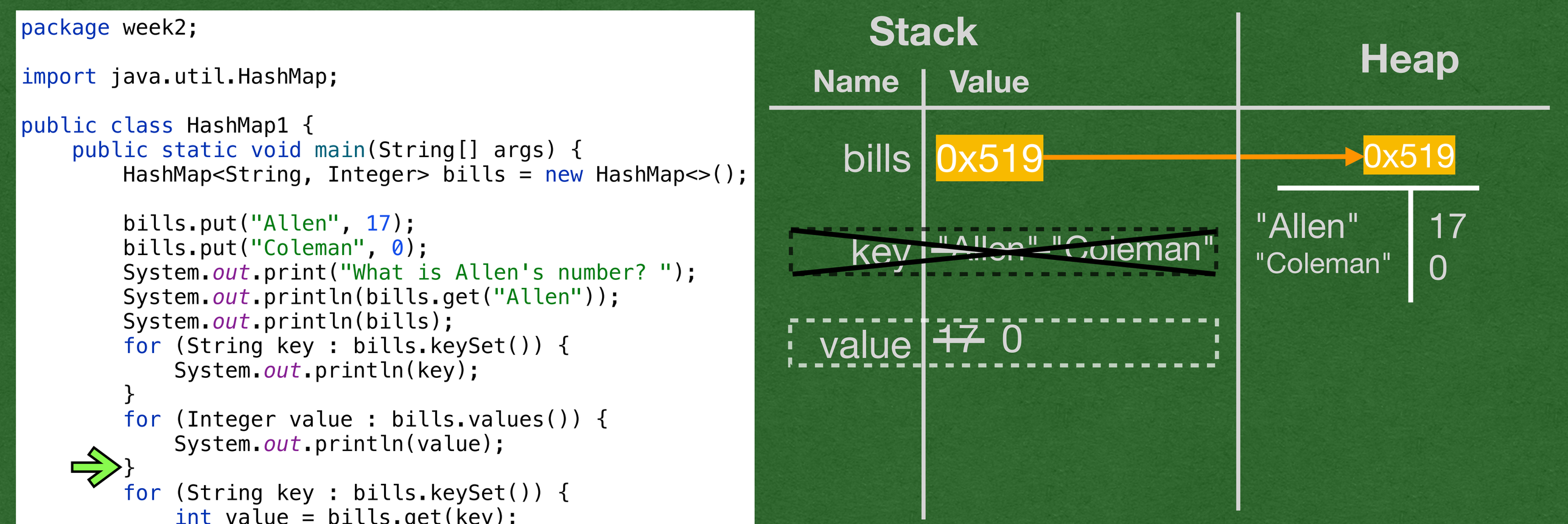


in/out

What is Allen's number? 17
{Coleman=0, Allen=17}
Allen
Coleman
17

- Iterating over the values only stores the values in the iteration variable

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

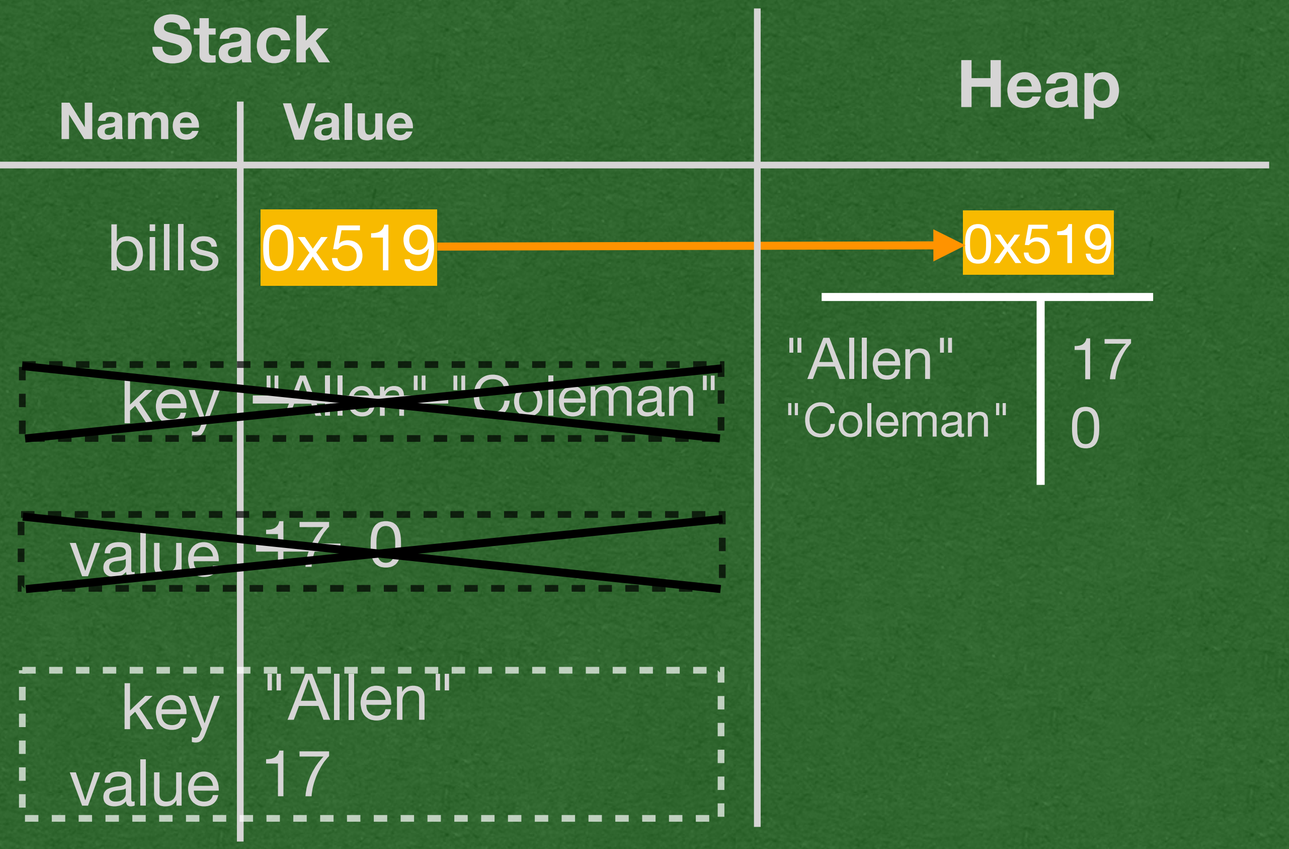


in/out

What is Allen's number? 17
{Coleman=0, Allen=17}
Allen
Coleman
17
0

- Iterate until we run out of values

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```

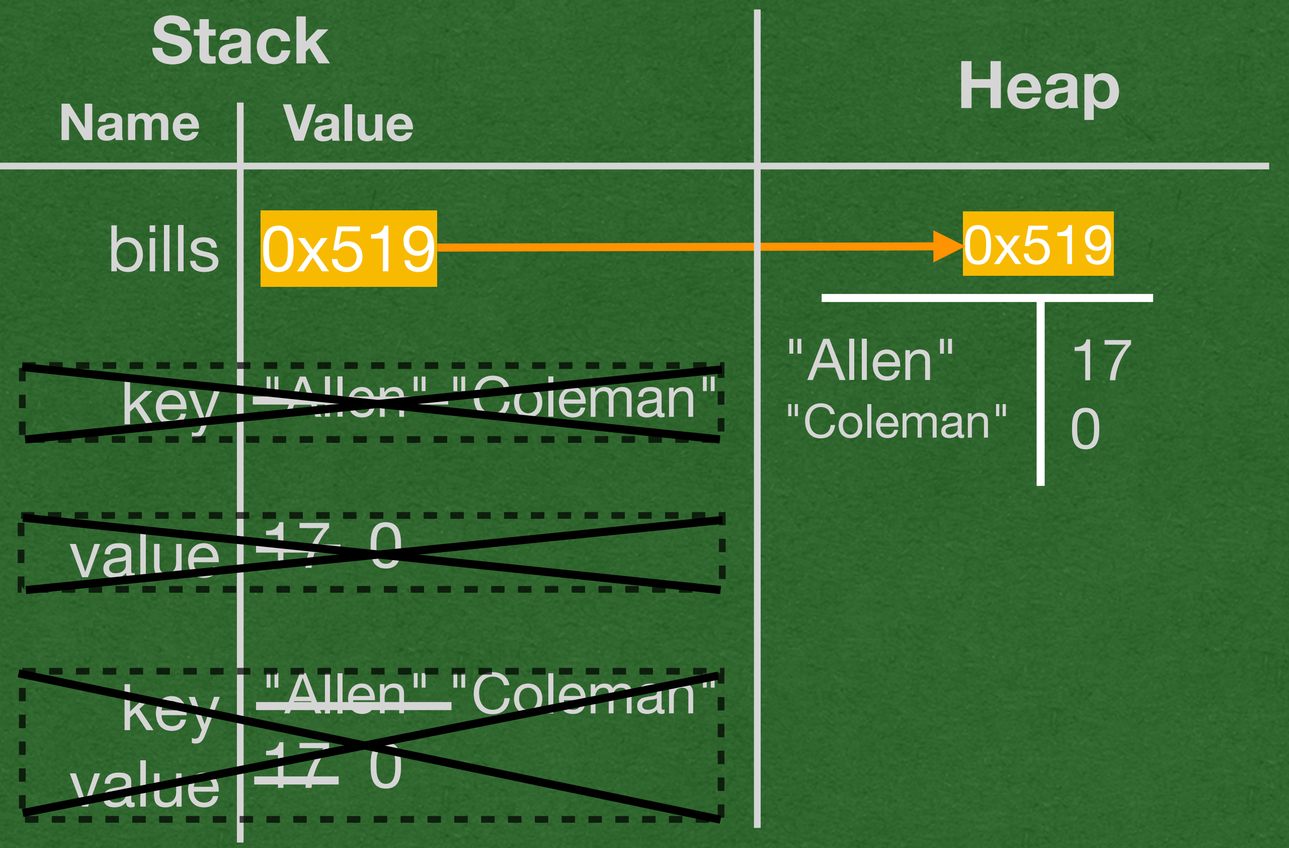


in/out

```
What is Allen's number? 17
{Coleman=0, Allen=17}
Allen
Coleman
17
0
Allen's number is: 17
```

- If we iterate over the keys and get the values, we can access the key-value pairs

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Coleman", 0);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```



- Reach the end of main
- That's the end of the program

in/out

What is Allen's number? 17
{Coleman=0, Allen=17}
Allen
Coleman
17
0
Allen's number is: 17
Coleman's number is: 0

Stack

Name	Value

Stack Frames

main

bills	0x002	Cross out
key	~~"Allen"~~	
	“Coleman”	Cross out
value	~~17~~	
	0	Cross out
key	~~"Allen"~~	
	“Coleman”	Cross out
value	~~17~~	
	0	Cross out

Uncross out this codeblock

Uncross out this codeblock

Uncross out this codeblock

Create Stack Frame

Heap

HashMap — No parent

Name	Value	
"Allen"	17	Cross out
“Coleman”	0	Cross out

0x002

Create Heap Object

IO

What is Allen's number? 17

{Allen=17, Coleman=0}

Allen

Coleman

17

14

Allen's number is: 17

Coleman 's number is: 0

Create IO Line

```java
package week2;

import java.util.HashMap;

public class HashMap1 {
    public static void main(String[] args) {
        HashMap<String, Integer> bills = new HashMap<>();

        bills.put("Allen", 17);
        bills.put("Diggs", 14);
        System.out.print("What is Allen's number? ");
        System.out.println(bills.get("Allen"));
        System.out.println(bills);
        for (String key : bills.keySet()) {
            System.out.println(key);
        }
        for (Integer value : bills.values()) {
            System.out.println(value);
        }
        for (String key : bills.keySet()) {
            int value = bills.get(key);
            System.out.print(key + "'s number is: ");
            System.out.println(value);
        }
    }
}
```