Objectives

- Enforcing encapsulation: Cloning
- Parameter passing

Extra Credit Opportunity:
"That Quiet Little Voice: When Design and Ethics Collide"

- Monday, Oct. 9 at 5 p.m.
  Stackhouse Theater
- George Aye
  - Co-founder and director of innovation at Greater Good Studio

https://columns.wlu.edu/george-aye-is-the-next-speaker-in-the-mudd-lecture-series/

Review

- What are benefits of programmatically/automatically testing (i.e., having the program execute test cases and determine if the test case fails)?

- What does `static` mean?
- What does a static method have access to?
- How do you call a static method?
- When should we make a method static?
  - What are static methods similar to in Python?
- When should we make a field static?
- How do you create pretty, formatted output?
  - What is the syntax? What are the components?

ENFORCING ENCAPSULATION

Encapsulation/Black-Box Programming Revisited

- Objects should hide their data and only allow other objects to access this data through **accessor** and **mutator** methods
- Common programmer mistake:
  - Creating an accessor method that returns a reference to a mutable (changeable) object

Example of Black-box Programming

```
private int height; // in cm
private double weight; // in lbs
…

public void feed() {
     weight += .3;
     height += 1;
}
```

- We don't want to allow direct changing of Chicken's state (height and weight)
  - Don't want them set to 0 or negative values
  - We want the height and weight to be proportional, so there are no separate setHeight and setWeight methods
- Only allowing access to the methods allows us to restrict the kinds of changes that can be made to the state of the object

Violating Black-Box Programming Principle

```
public class Farm {
        . . .
        private Chicken headRooster;

        public Chicken getHeadRooster() {
                return headRooster;
        }
        . . .
}
```

Violating Black-Box Programming Principle

```
public class Farm {
        . . .
        private Chicken headRooster;

        public Chicken getHeadRooster() {
                return headRooster;
        }
        . . .
}
```

Problem: Giving others access to Farm's headRooster through the *public* getHeadRooster method.
Others can then feed your rooster or change his name!!
(Silly example; understand consequences)

```
public class OtherCode {
        . . .
        Chicken stolen = farm.getHeadRooster();
        . . .
}
```

Fixing the Problem: Cloning

```
public class Farm {
        . . .
        private Chicken headRooster;

        public Chicken getHeadRooster() {
                return (Chicken) headRooster.clone();
        }
        . . .
}
```

Method is available to all objects (inherited from `Object`)

- In previous example, could modify returned object's state
- Here, another `Chicken` object, with the same data as `headRooster`, is created and returned to the user
- If the user modifies (e.g., feeds) that object, `headRooster` is not affected

Cloning

- Cloning is a more complicated topic than it seems from the example
  - Out of scope for this class
- See *Effective Java* for more information

What about the Chicken's getter methods?

```
public class Farm {
        . . .
        private Chicken headRooster;

        public Chicken getHeadRooster() {
                return headRooster;
        }
        . . .
}
```

Problem: Giving others access to Farm's headRooster through the *public* getHeadRooster method.
Others can then feed your rooster or change his name!!
(Silly example; understand consequences)

But: Why was it okay to return the name, height, or weight of a chicken?
Similar to Python, primitive types and Strings are *immutable*.
Since those attributes have immutable data types (String, int, double, respectively), others can't change those attributes when retrieved using a getter method.

PARAMETER PASSING

Method Parameters in Java

- Java always passes parameters into methods ***by value***
  - Meaning: the formal parameter becomes a copy of the argument/actual parameter's value
    - caller and callee have two independent variables with the *same* value
  - Consequence: Methods can**not** change the ***variables*** used as input parameters
  - A subtle point, so we will go through several examples
- Python is something that's not quite pass-by-value—it depends on if the object is mutable or immutable
  - *Pass-by-alias* is one term used

Method Parameters in Java

```
public static void main(String[] args) {
    int x = 10;
    int squared = square(x);
    System.out.println("The square of " + x + " is " +
                                squared);
}

public static int square(int num) {
    return num*=num;
}
```

Draw the stack as it changes
(similar to Python):

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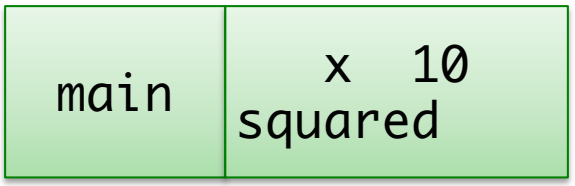
Draw the stack as it changes (similar to Python):



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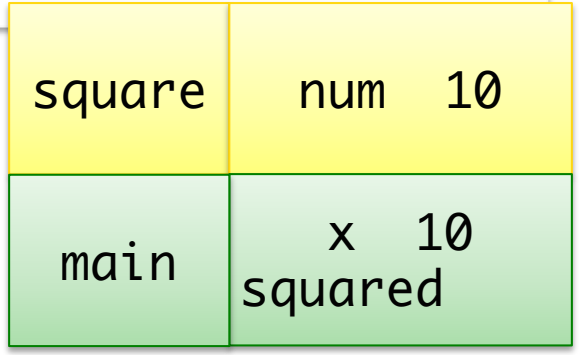
num copies the value of x



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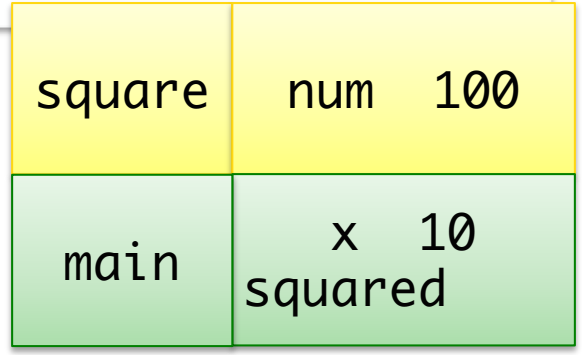

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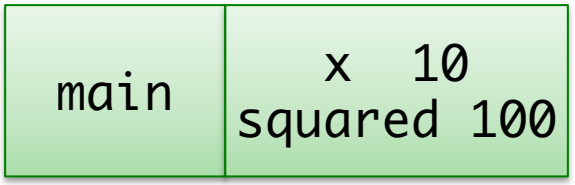
}
```

Output:

```
The square of 10 is 100
```



What's the Output?

```
public static void main(String[] args) {
        int x = 27;
        System.out.println(x);
        doubleValue(x);
        System.out.println(x);
}
public static void doubleValue(int p) {
        p = p * 2;
}
```

1. Think (independently) for 1 minute
2. Share with your neighbor.
3. Discuss as class

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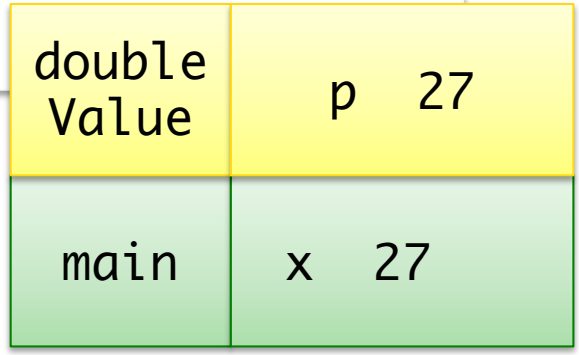
Output (so far):

27



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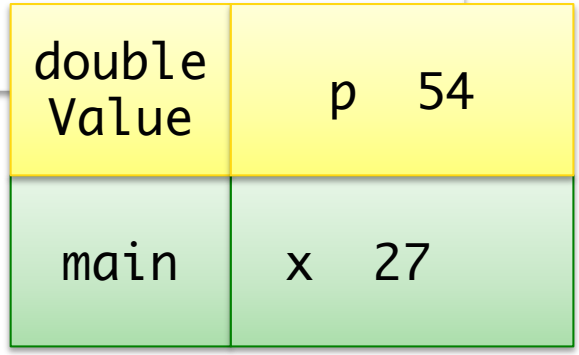

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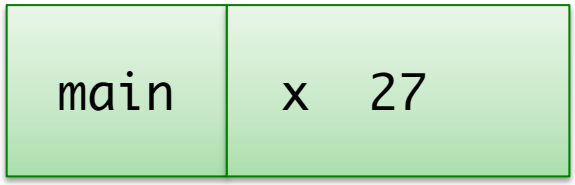
```



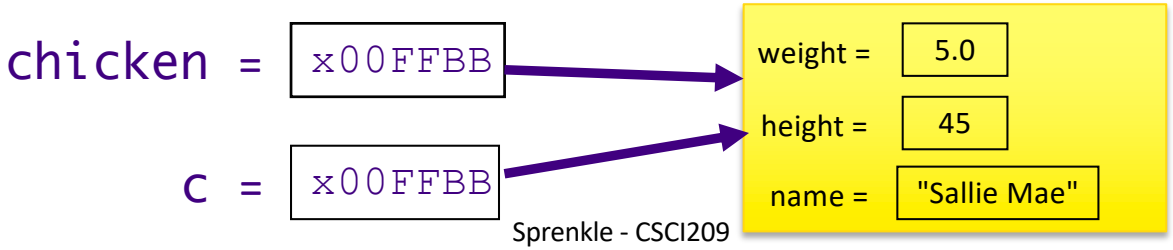
Pass by Value: Objects

- Primitive types are a little more obvious
  - Can't change original variable
- For objects, passing a copy of the parameter looks like:

```
public void methodName(Chicken c)
```

- Pass `Chicken` object variable to `methodName` when calling method:

```
methodName(chicken);
```



Pass by Value: Objects

- What happens in this case?

```
methodName(chicken);
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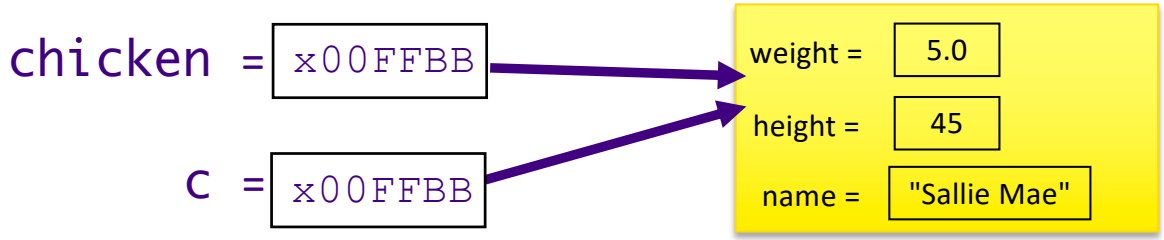


```
public void methodName(Chicken c) {
        if( c.getWeight() < MIN ) {
                c.feed();
        }
        …
}
```

Can the Chicken object be changed in the called method?

Pass by Value: Objects

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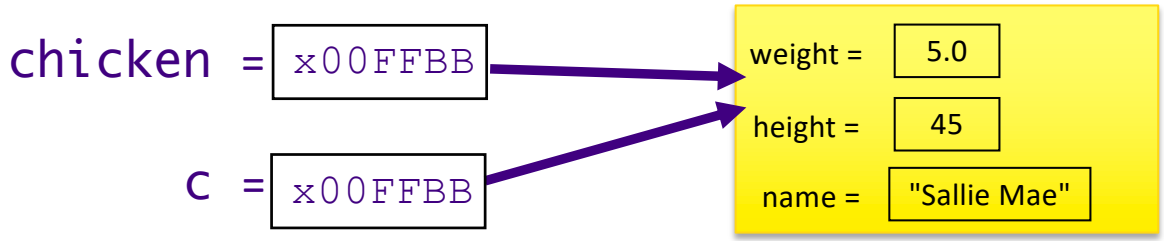


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        }
        …
}
```

Can the Chicken object be changed in the called method?

YES! Both `chicken` and `c` are pointing to the *same* Chicken object

Example 1: What's the Output?

```
Farm farm = new Farm("OldMac");
Chicken sal = new Chicken("Sallie Mae", 5.0, 45);
System.out.println(sal.getWeight());
farm.feedChicken(sal);
System.out.println(sal.getWeight());
. . .

// From Farm class
public void feedChicken(Chicken c) {
    c.setWeight( c.getWeight() + .5);
}
```

(`setWeight` was not a method defined in our Chicken class; just for this example)

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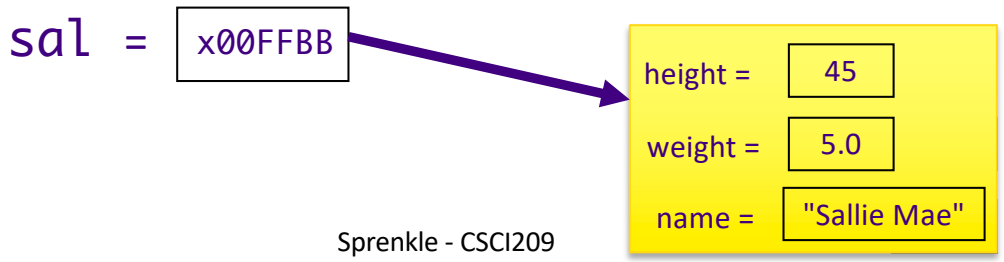

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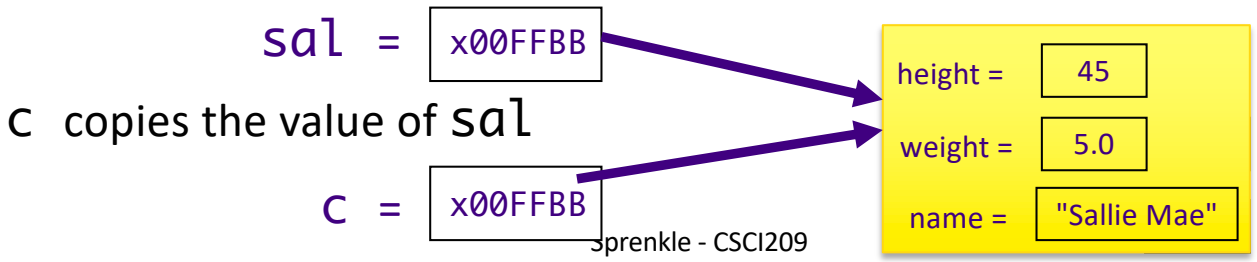

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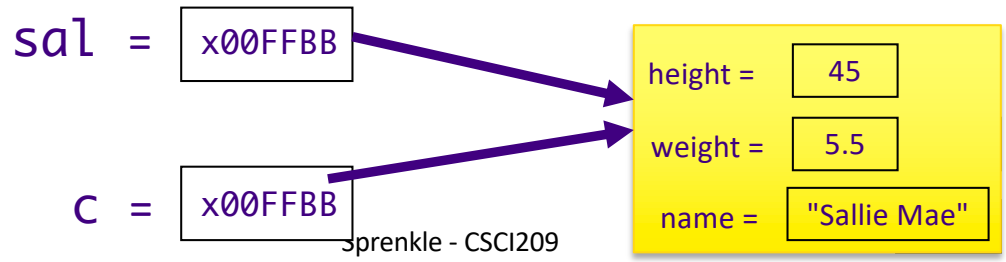

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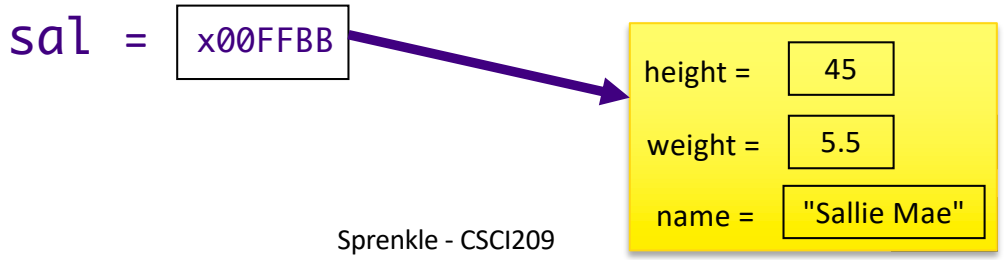
```
5.0
5.5
```



Example 2: What's the Output?

```
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System.out.println(sal.getWeight());
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public void feedChicken(Chicken c) {
    c = new Chicken(c.getName(), c.getWeight(), c.getHeight() );
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Example 2: Tracing through Execution

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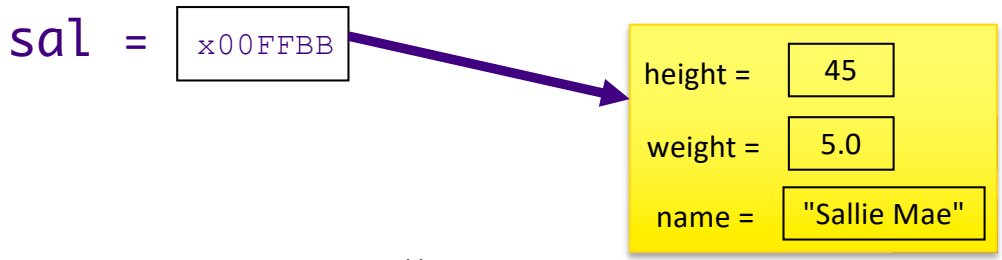

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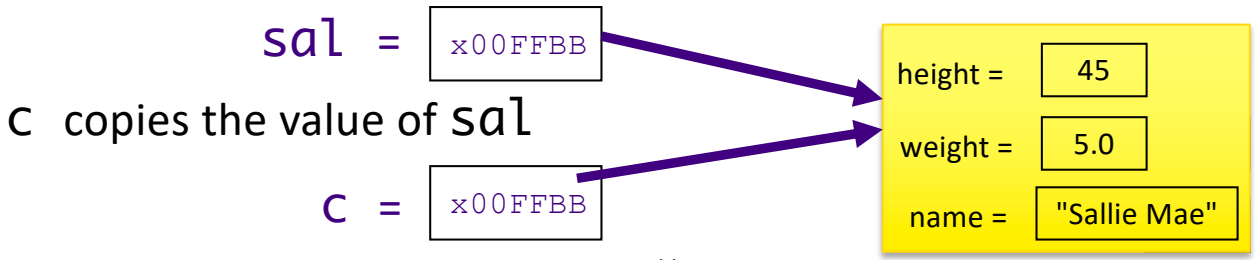

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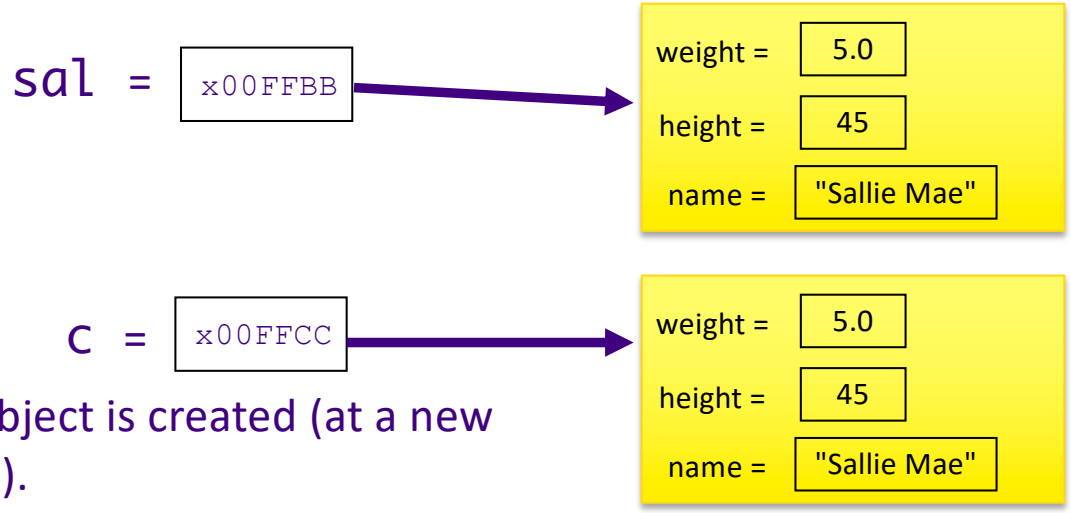

A new Chicken object is created (at a new memory address).

c is assigned to/references that object.

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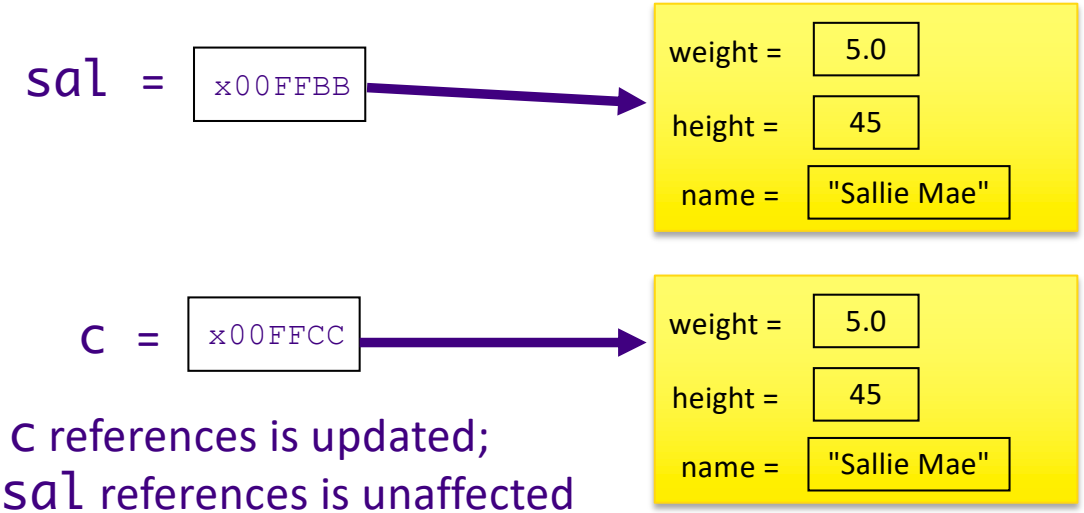

The object that c references is updated;
the object that sal references is unaffected

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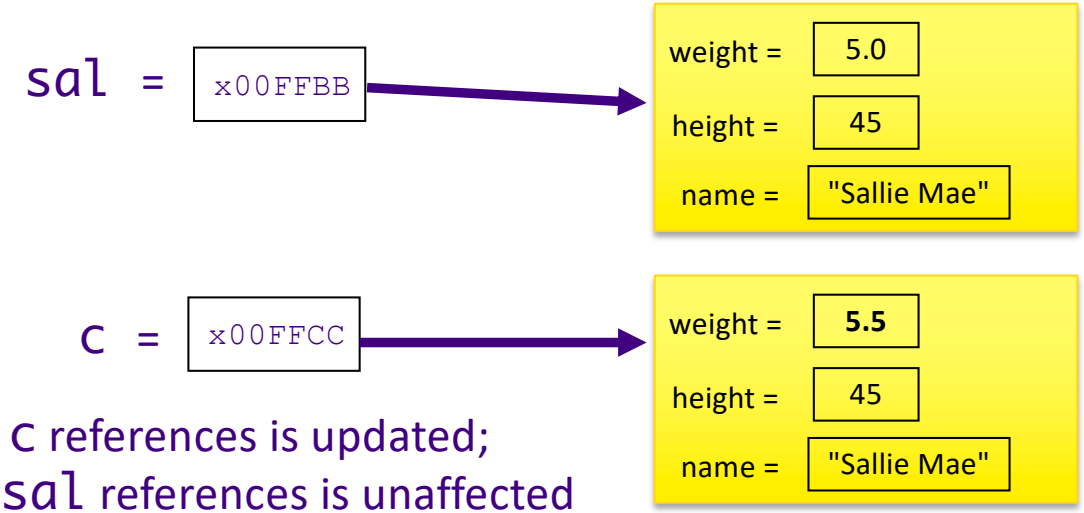

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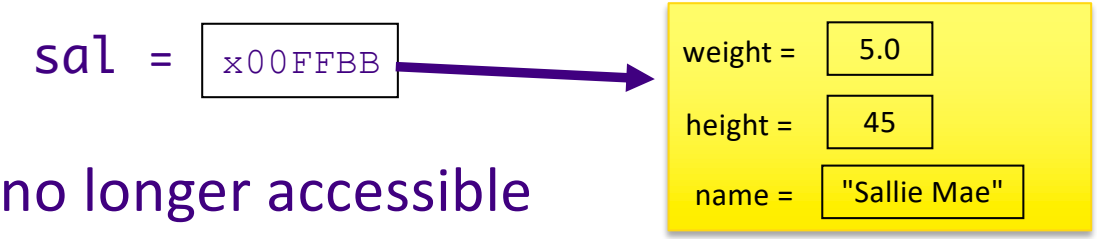
```
5.0
5.0
```



c is out of scope/no longer accessible

Summary of Passing Parameters to Methods

- Everything is passed ***by value*** in Java

- An **object *variable*** (not an object) is passed into a method
  - Changing the *state* of an object in a method changes the state of object outside the method
  - Called method does **not** get a copy of the original object

Looking Ahead: Assignment 3

- Assignment 3 – due Thursday at 11:59
  - Building on the Birthday class
    - Overloading constructor
    - Overriding methods
  - Creating an application, practicing
    - Control structures
    - Using your own class and classes from the Java API

Looking Ahead: Exam 1

- Exam 1 – Friday
  - Online, timed exam: 70 minutes
    - No class Friday but Sprenkle will hold office hours
    - Opens: Friday at 8:00 a.m.; Closes: Sunday at 11:59 p.m.
  - Open book/notes/slides – but **do not** rely on that
    - NOT open internet
  - Prep document online
  - 3 sections:
    - Very Short Answer, Short Answer, Coding