Objectives

- Creating our own classes
  - Testing
  - Object variables
  - Object initialization
  - Overloading
  - Documentation: Javadocs
  - Inheritance, Overriding

Review

- What are the standard streams?
  - How do we access them in Java?
- What is black-box programming?
  - What are the benefits of black-box programming?
  - How does Java help enforce black-box programming?
- What is the structure of a Java class?
  - What does it contain?
  - What are the syntax rules?
  - What are our conventions for ordering the class?
- What is the Java equivalent of `self`?

Note: Static vs Instance Methods

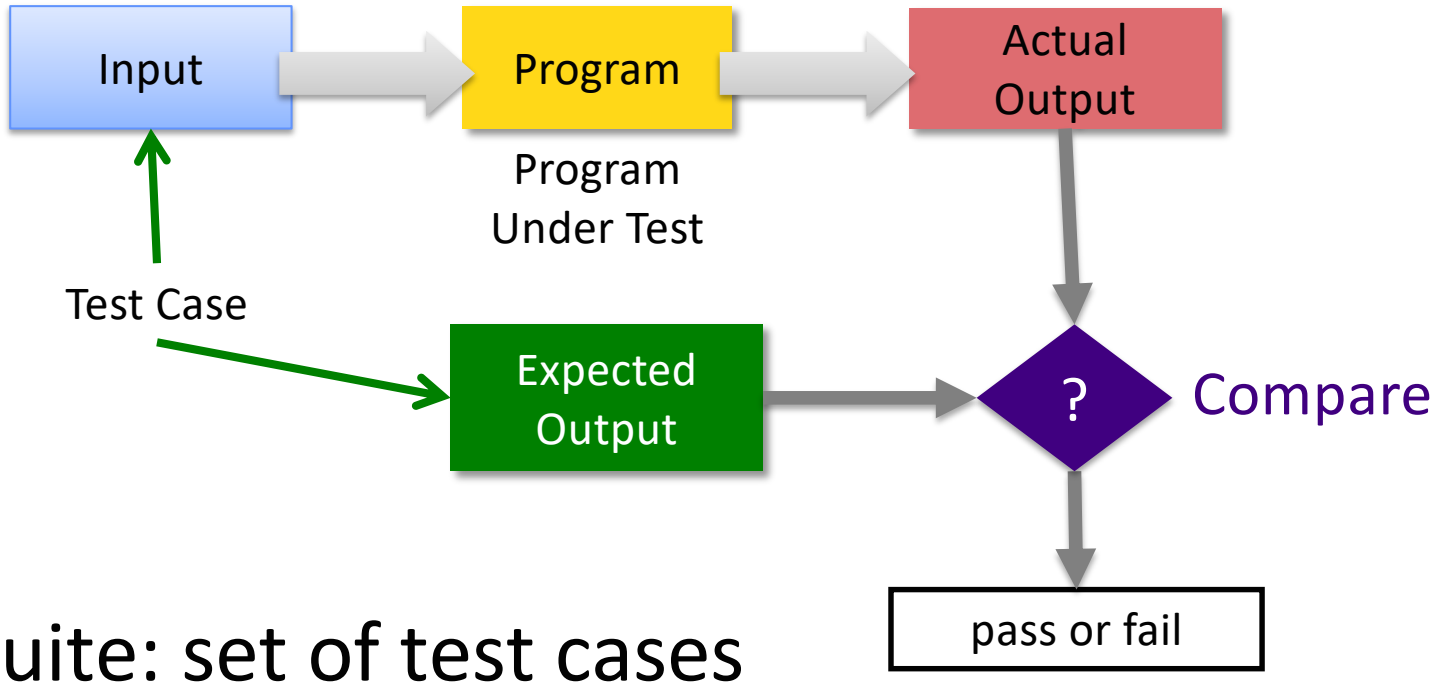
- `main` is a **`static`** method
- The methods we've been defining so far are ***not*** static
  - They do not have the **`static`** keyword as a modifier
  - They are therefore *instance* methods

More on this later…

Chicken's `main` method

- Where we'll do testing
  1. Create object
  2. Call methods
  3. Verify methods' results are what you expect
- When done testing, can move tests into separate test method
- Later: better ways to test

Software Testing Process



- Test Suite: set of test cases

Software Testing Process

- Tester plays devil's advocate
  - ***Hopes*** to reveal problems in the program using "good" test cases
  - Better tester finds than a customer!

How is **testing** different from **debugging**?

Our Tests in `main`

- Execute the code to expose errors, automatically/programmatically
- Compare what we expect to the actual value
  - For mutators, this usually requires two steps:
    - Execute the method
    - Use other methods to check that the appropriate mutation occurred
- If actual and expected are different, displays an error message

`Chicken.java`

Class Development Process

1. Determine state
   - Declare state at top of class
   - Consider access modifier
2. Define constructor
   - Consider parameters to constructor
   - Call constructor/create an object
3. Repeat
   - Write method or constructor
     - Consider return type (for methods), parameters, and access modifiers
   - Test new method or constructor in `main`
     - 2 stages: Just exercising the method; then more systematically
4. Optional: Move testing code to a private testing method

Review Testing in Chicken Class

- Note use of standard out vs standard error

Access Modifier Example

- If a method is *private* to a class, other classes cannot call that method.

```
public static void main(String[] args) {
    Chicken myChicken = new Chicken("Fred", 10, 2);
    myChicken.feed();

    // this will result in a compiler error:
    myChicken.privateMethod();
}
```

NotAChickenClass.java

JAVADOCS

JavaDocs for Methods

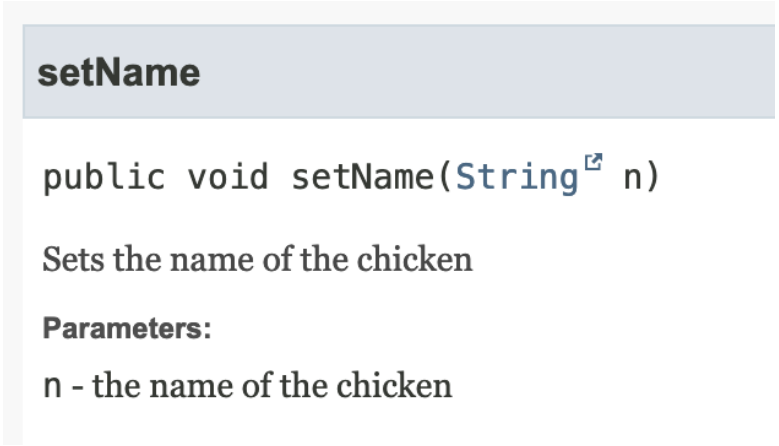
From String class

```
/**
 * Returns the string representation of the boolean argument.
 *
 * @param b - a boolean
 * @return if the argument is true, a string equal to "true" is
 *         returned; otherwise, a string equal to "false" is
 *         returned.
 */
public static boolean valueOf(boolean b) {
```

- Use format similar to class comments
- Use `@param` tag(s) to describe what method takes as parameter(s)
- Use `@return` tag to describe what method returns

JavaDocs for Methods: Chicken Example

```
/**
 * Sets the name of the chicken
 *
 * @param n the name of the chicken
 */
public void setName(String n) {
```



setName

`public void setName(String n)`

Sets the name of the chicken

Parameters:

`n` - the name of the chicken

Generated on Web Page:

https://cs.wlu.edu/~sprenkles/cs209/javadocs/08-oo/Chicken.html

JavaDocs for Methods

```
/**
 * Returns the string representation of the boolean argument.
 *
 * @param b - a boolean
 * @return if the argument is true, a string equal to "true" is
 *         returned; otherwise, a string equal to "false" is
 *         returned.
 */
public static boolean valueOf(boolean b) {
```

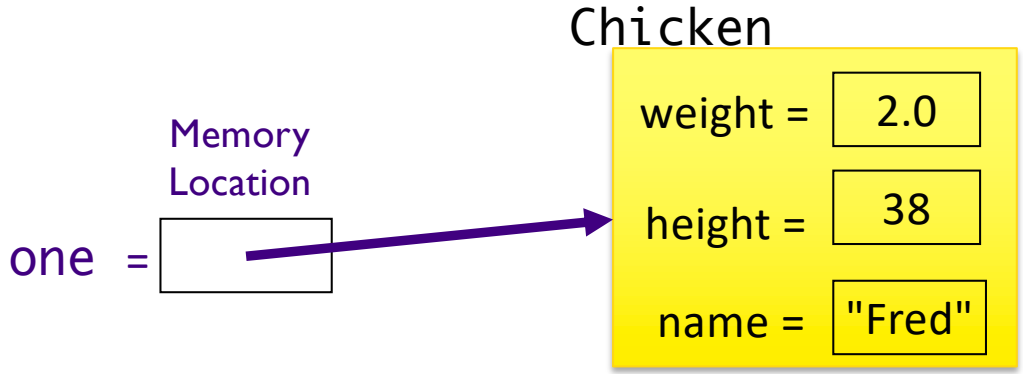
- Expectation in CSCI209: **All** methods will have JavaDoc comments
  - Exception: `main` method – sometimes covered by the *class*'s JavaDoc but sometimes needs more explanation

OBJECT REFERENCES

Variables: Object References

- Variable of type Object (not a primitive type): value is memory location

```
Chicken one = new Chicken("Fred", 38, 2.0);
```

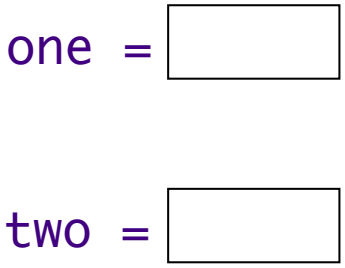


1. Constructor creates the object in memory
2. The *variable* stores the object's *location* in memory

Object References

- Variable of type Object: value is memory location

```
Chicken one;
Chicken two;
```



Variables are declared (only).
There are no memory locations to reference, so both `one` and `two` are equal to `null`

This is the case for *objects.*
Primitive types are *not* `null`.

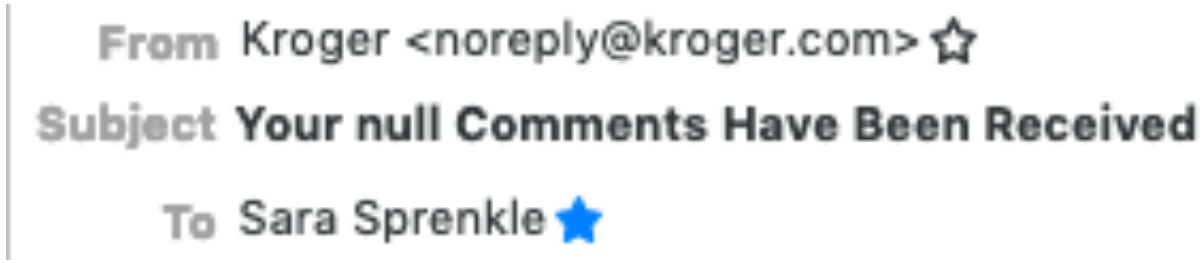
Null Object Variables

- An object variable can be explicitly set to `null`
  - Means that the object variable does not currently refer to any object

- Can test if an object variable is set to `null`:

```
Chicken motherHen = null;
    … … …
if (motherHen == null) {
        . . .
}
```

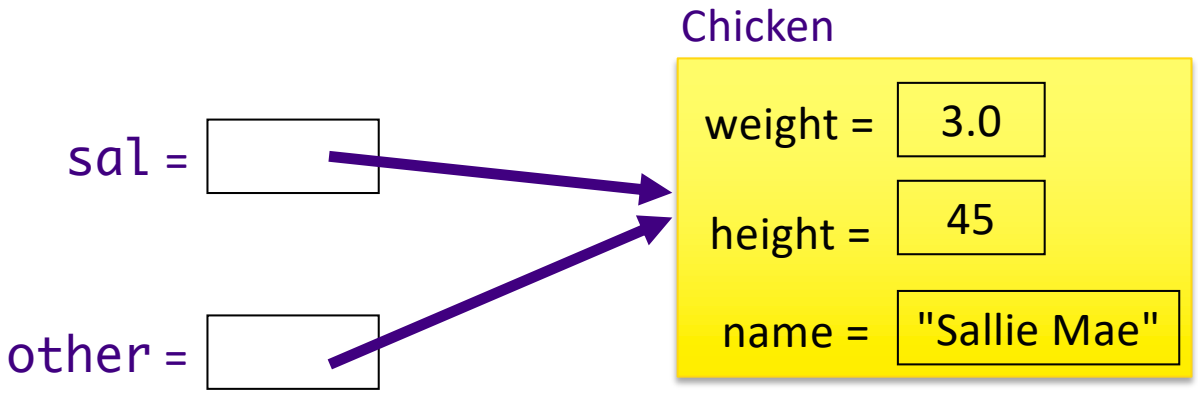
Recall This Error Message



Multiple Object Variables

- More than one object variable can refer to the same object

```
Chicken sal = new Chicken("Sallie Mae");
Chicken other = sal;
```



More on

CONSTRUCTORS

Constructor Fun Facts

- A constructor can have zero, one, or multiple parameters
- A constructor has no return value
- A constructor is always called with the new operator
- A class can have **more than one** constructor

Overloading

- Allowing > 1 constructor (or any method) with the same name is called ***overloading***
  - Constraint: Each of the methods that have the same name or constructor **must** have **different parameters** so that compiler can distinguish between them
    - "**different**" → *Number* and/or *type*
- *Compiler* handles ***overload resolution***
  - Process of matching a method call to the correct method by matching the parameters
- Can't overload functions in Python

`overload.py`

Default Constructor

- ***Default constructor*: constructor with no parameters**
- If class has *no constructors,* ***compiler*** automatically provides a default constructor
  - Sets all instance fields to their default values
- If a class has at least one constructor and no default constructor, default constructor is NOT provided

Default Constructor

- Chicken class has one constructor:

```
Chicken( String name, int height, double weight )
```

➡ No default constructor

```
Chicken chicken = new Chicken();
```

  - Above code is a compiler error

Constructors Calling Constructors

- Can call a constructor from another constructor
- To call another constructor of the same class, the **first** statement of constructor must be

```
this( . . . );
```

  - `this` refers to the object being constructed

Why would you want to call another constructor?

Constructors Calling Constructors

- Why would a constructor call another constructor?
  - Reduce code size, reduce duplicate code
- Ex: if Chicken's name is not provided, use default name

```
Chicken( int height, double weight ) {
    this( "Bubba", height, weight );
}
```

- Another example:

```
Chicken( int height, double weight ) {
    this();
    this.height = height;
    this.weight = weight;
}
```

Not in example code online

Summary: Overloading

- Overloading is when you define multiple constructors or multiple methods with the same name
- Constraint: Each of the methods that have the same name or the constructor **must** have **different parameters**
  - "**different**" → *Number* and/or *type*
- Compiler distinguishes between the methods/constructor

MORE ON OBJECT INITIALIZATION

Default Object State Initialization

- If instance field is not explicitly set in constructor, automatically set to default value
  - Numbers set to zero
  - Booleans set to `false`
  - Object variables set to `null`
- But, **do not** rely on defaults
  - Code is harder to understand

(Aside: recall that local variables are **not** assigned defaults)

Clean Code Recommendation:
Set all instance fields in the constructor(s)

Explicit Field Initialization

- If more than one constructor needs an instance field set to same value, the field can be set explicitly in the field declaration

```
class Chicken {
        private String name = "";
        . . .
}
```

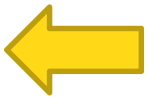
Set value here for all constructors

Explicit Field Initialization

- Explicit field initialization happens before any constructor runs
- A constructor can change an instance field that was set explicitly

```
class Chicken {
        private String name = "";

        public Chicken( String name, … ) {
                this.name = name;
                …
        }
…
```



Explicit field initialization

Change explicit field initialization

`final` keyword for fields

- When modifier of a field, `final` means ***field cannot be changed after object is constructed***
- `final` instance fields **must** be set in the constructor or in the field declaration

```
private final String dbName = "invoices";
private final String id;

public MyObject( String id ) {
      this.id = id;
}
```

BASICS OF JAVA INHERITANCE

Parent Class: `Object`

- Every class you create *automatically* inherits from the `Object` class
  - See Java API
- Examples of class hierarchies (from Java API):

Class String

java.lang.Object
    java.lang.String

Class JFrame

java.lang.Object
    java.awt.Component
        java.awt.Container
            java.awt.Window
                java.awt.Frame
                    javax.swing.JFrame

Overriding Methods

- You can ***override*** methods from parent classes
- Useful `Object` methods to override to customize your class
  - `String toString()`
    - Returns a string representation of the object
    - Like Python's `__str__`
  - `boolean equals(Object o)`
    - Return `true` iff this object and `o` are equivalent
    - Like Python's `__eq__`

Note method signatures

@Override

```
@Override
public boolean equals(Object obj) {
```

- Annotation
- Tells compiler "This method overrides a method in a parent class. It should have the same signature as that method in the parent class."
- If your method signature does not match the overridden method, then the compiler will give you an error

Use @Override so you don't make silly—yet costly—mistakes

`String toString()`

- Automatically called when object is passed to `print` methods
- Default implementation: Class name followed by @ followed by unsigned hexidecimal representation of hashcode
  - Hashcode is typically the internal address of the object
  - Example: `Chicken@163b91`
- General contract:
  - "A concise but informative representation that is easy for a person to read"
- Your responsibility: ***Document the format***

Chicken's toString

- What would be a good string representation of a Chicken object?
  - Look at output before and after `toString` method implemented

`boolean equals(Object o)`

Note method signature

- Procedure (Source: *Effective Java*)
  1. Use the == operator to check if the argument is a reference to this object
  2. Use the `instanceof` operator to check if the argument has the correct type
     - If a variable is a null reference, then `instanceof` will be false
  3. Cast the argument to the correct type
  4. For each "significant" field in the class, check if that field of the argument matches the corresponding field of this object
     - For doubles, use Double.compare and for floats use Float.compare

How should we determine that two Chickens are equivalent?

Checking an Object's Type

- Use the `instanceof` operator to see if an object implements an interface or is an object of the given type
  - e.g., to determine if an object is a `String`:

```
if (obj instanceof String) {
        // runs if obj is an object variable of type String
}
else {
        // runs if obj is not an object variable of type String
}
```

Implementing `equals`: What Not to Do

- It is not recommended that you turn the objects into Strings (using `toString`) and then compare
  - While the outcome may be correct, String operations are *expensive*
  - String representation may not represent all of the object

- Instead, compare fields directly

Summary: Inheritance So Far

- Every class inherits from `Object` class
- Can override methods of parent class(es)
- Useful `Object` methods to override:
  - `String toString()`
  - `boolean equals(Object o)`

Looking Ahead

- Assign 2 – due Wednesday
- Exam 1 – Friday
  - Timed exam: 60 minutes
  - Prep document online
  - Can have one letter-size page of notes for reference
  - 3 sections:
    - Very Short Answer, Short Answer, Coding