Objectives

- Static Fields and Methods
- Formatting

Review

- What is the format for documenting methods/constructors?
- What is overloading?
- How do we make an instance variable unchangeable after construction?
- How do we call a constructor within a constructor?
- What is the root of the Java class hierarchy?
- What is overriding?
  - What does the `@Override` annotation do?
- What method should we implement to allow pretty printing of objects we define?
- What method should we implement for determining if two objects are equivalent?

STATIC METHODS AND FIELDS

`static` Methods/Fields

- For functionality/data that is specific to a *class*
  - And is **not** specific to a particular object

`static` Methods/Fields Case Study: `java.lang.Math`

- No [public] constructor (What does that mean?)
- To refer to static field: `ClassName.field`
  - Math's static fields: `PI`, `E`
  - Example: `Math.PI`
- To call static method: Example `ClassName.methodName(…)`
  - A static Math method: `static double sin(double a)`
    - `Math.sin( number );`

Static Methods

`ClassName.method(…)`

- Do **not** operate on objects
  - i.e., you do **not** call ~~object.staticMethod();~~
- Can**not** access *instance* fields of their class

- Can access *static fields* of their class
  - Example: `Math` class could have a static method that uses `PI`
- Similar to Python *functions* that are associated with the class

Analyzing `java.lang.String` API

- Consider a "typical" instance (not static) method:

  `String toUpperCase()`

  - Converts all of the characters in *this String* to upper case
  - Example use:

    1) create a string `myString`

    2) call `myString.toUpperCase()`

Analyzing `java.lang.String` API

- `String toUpperCase()`
  - Converts all of the characters in *this String* to upper case
  - Example: create a string, call `myString.toUpperCase()`
- `static String valueOf(boolean b)`
  - Returns the string representation of the `boolean` argument
  - Example use: `String.valueOf(false);`

Why can/should this method be `static`?

java.util.Arrays

- Arrays is a class in java.util
- Methods for sorting, searching, deepEquals, fill arrays
- To use class, need **import** statement
  - Goes at top of program, before class definition

```
import java.util.Arrays;
```

Discussion

Why is `main` static?

`main()`

- Most common `static` method
- `main()` does not get called on an object
  - Runs when a program starts
  - There are no objects yet but there is the class
- `main()` executes and constructs the objects the program needs and will use
  - Like the ***driver function*** for the program

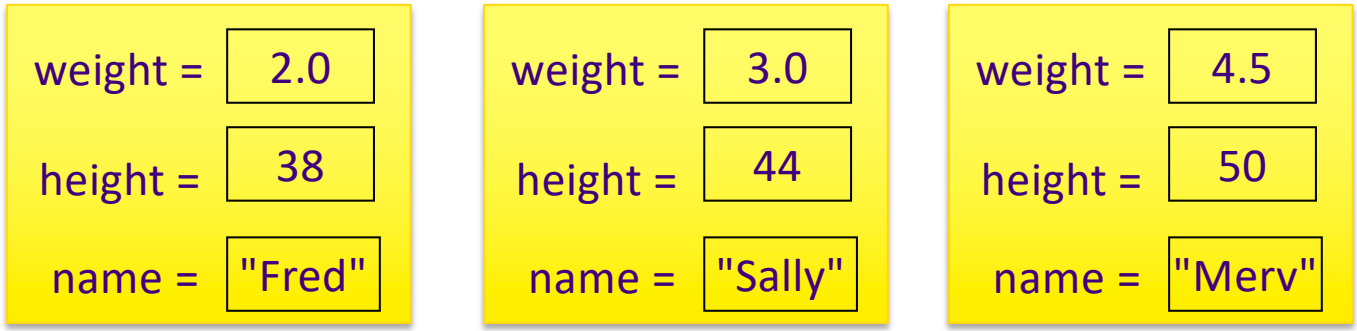
INTEGRATING STATIC INTO OUR CLASSES

Chicken `static` Field Example

```
static String farm = "McDonald";
```

Chicken objects

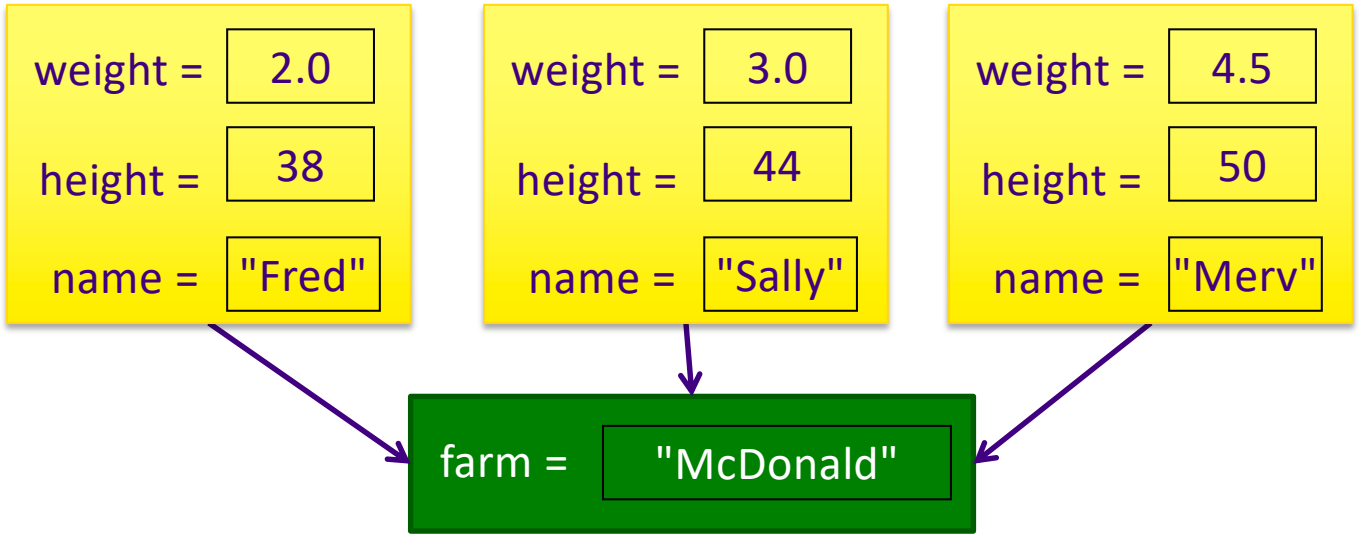
We have a bunch of Chicken objects



Chicken static Field Example

```
static String farm = "McDonald";
```

We have a bunch of Chicken objects



One variable shared by all members of the class.

Chicken static method Example

```
public static String getFarm() {
    return farm;
}
```

Call on Chicken class:

```
Chicken.getFarm();
```

More Examples

- Putting our testing code in a test method
- Creating a user interface for the chickens

`Chicken.java`

Static Summary

- Static fields and methods are **part of a class** and **not** an object
  - Do not require an object of their class to be created to use them
- Similar role to a Python function
- When would we make a method `static`?
  - When a method does not need to access an *object's* state (fields) because all needed data are static fields in the class or are passed into the method
- When would we make a field `static`?
  - When it's a class variable (i.e., there should only be one for the whole class)

Summary: Class Design/Organization

- Fields
  - Chosen first
  - Placed at the beginning or end of class definition
  - For class or instance?
  - Have an access modifier, data type, variable name, and maybe optional modifiers
- Constructors
  - Have an access modifier
  - Set all fields explicitly
  - Use `this` keyword to access the object
- Methods
  - Have an access modifier
  - Need to declare the return type

FORMATTING

Formatting Strings: `format`

- Static method of the String class
- `String.format(<templatestring>, <value1>, <value2>, …, <valuen>)`

  Replacement values
- Semantics: creates, returns a **formatted string**
  - Means "format the templatestring, using the format(s) specified by **format specifiers** on the corresponding replacement values"
- Typically used with print statements

Formatting Strings

- **`templatestring`** is a template for the resulting string with format specifiers instead of the values
  - For each format specifier in templatestring, should have a ***replacement value***

```
String.format("%.2f", 3.14159 );
```

result is `"3.14"`

One format specifier

Corresponding replacement value

Format Specifiers

[] mean optional

- General format:
  `%[flags][width][.precision]conversion`
  - flags:
    - 0: zero fills
    - +: adds a + sign before positive values
    - -: left-justification (default is right-justification)
  - width:
    - *Minimum* number of character spaces reserved to display the entire value
    - Includes decimal point, digits before and after the decimal point and the sign

Format Specifiers

- General format:

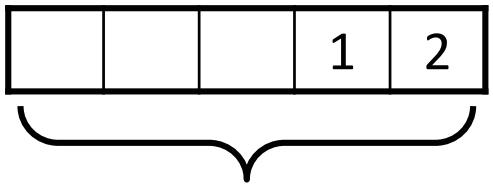
  `%[flags][width][.precision]conversion`

  - precision:
    - Number of digits after the decimal point for **floating point** values
  - conversion:
    - Indicates the value's **type/**way to format

Conversion	Type
s	string
d	integer
f	float/double

Example Format Specifiers

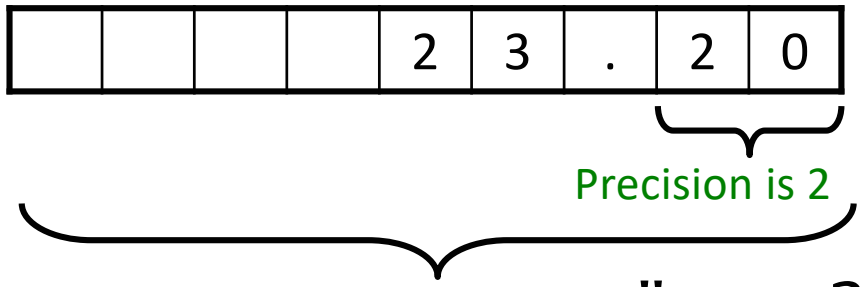
```
String.format("%5d", 12)
```




```
"   12"
```

Right-justified

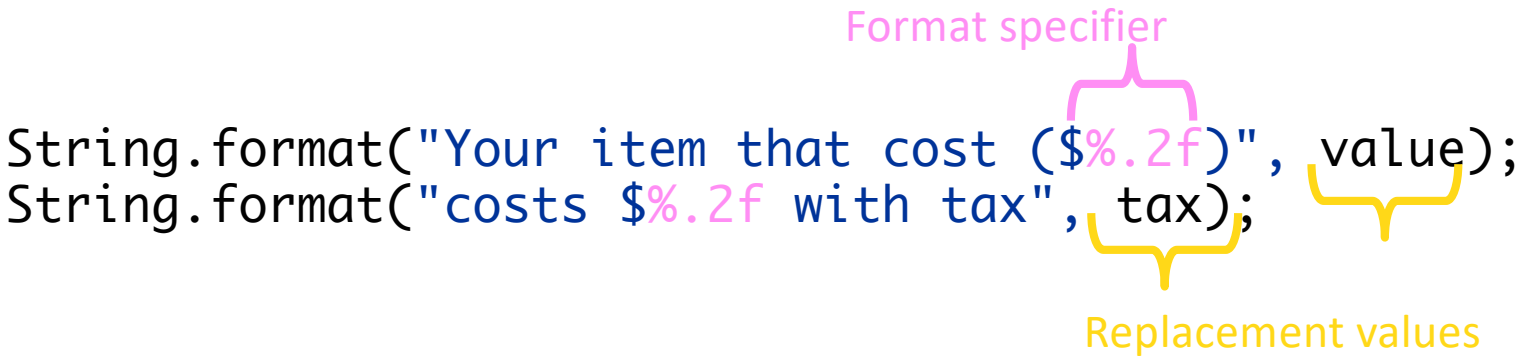
```
String.format("%9.2f", 23.1999)
```




```
" 23.20"
```

- What if precision is bigger than the decimal places?
  - Fills decimal with 0s
- What if field width is smaller than the length of the value?
  - String contains entire value

Partial Examples using format



Common use case:

Save each of these in two (String) variables and print them

Example: Printing Out Tables

- A table of temperature conversions

```
Temp F      Temp C      Temp K
------      ------      ------
-459.7      -273.1        0.0
   0.0       -17.8      255.4
  32.0         0.0      273.1
```

- If we want to print data in rows, what is the template for what a row looks like?
  - How do we make the column labels line up?

TemperatureTable.java

Example: Printing Out Tables

Using `String.format`

```
// example for one line of data in the table
double[] temps = {-459.7, -273.1, 0.0};

String tempFormat = "%10.1f %10.1f %10.1f";

System.out.println(String.format(tempFormat,
      temps[0], temps[1], temps[2]));
```

Example: Printing Out Tables

Using System.out.printf

```
// example for one line of data in the table
double[] temps = {-459.7, -273.1, 0.0};

String tempFormat = "%10.1f %10.1f %10.1f\n";

System.out.printf(tempFormat,
      temps[0], temps[1], temps[2]);
```

Static Method Practice

- Implement a `static` method called `average` that
  - Takes as parameters 2 integers
  - Returns the average of those 2 numbers
- What should the signature of this method look like?
  - Use the `main` method's signature to guide you
  - Discussion: what is the method's return type?
- Discussion: Why should this be a static method?

`Calculator.java`

Putting it Together

- `main` will prompt user for two integers and display the result of getting the average
  - `main` is the driver
- Development process
  1. Hardcode the numbers
  2. Switch to user input
- How do we call the method?
  - Note that it is different because method is being called from another class

`Main.java`

Assignment 3

- Lots of flexibility in design in `Birthday` and `BirthdayParadox`
- Lots of different correct designs
  - BUT, many more incorrect or too-complicated designs
- Consider
  - If a variable should be a local variable, instance variable, or class variable
  - How can I break this into smaller problems? → Methods!
  - API for the methods: What is its input? What is its output (what is returned)?
- Test small parts!
- Use git well
  - When are good points to checkpoint (commit) or make a new branch?

Looking Ahead

- Assign 3 – due Thursday 11:59 p.m.
- 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