Objectives

- Standard Streams
- Object Oriented Programming
  - OOP review
  - Black-box programming
  - Creating classes in Java
    - State
    - Constructor
    - Methods
- Testing classes

Review

- What is the Java syntax for
  - Conditionals?
  - Loops? (three different loops)
- How do you create a new array?
  - provide a few variations
- What are command-line arguments?
  - How do we access/use them in Java?
- What does == check in Java? What is its Python equivalent?
- Review object-oriented programming terminology

Methods and Arrays

- You cannot call a method on an array because arrays are not objects
- You **can** *pass in* an array to a method
- Example:
  - `Arrays.sort(args)`
  - `args` is a being passed into the method
  - You could not compile args.method()

Example FileExtensionFinder

```java
/**
 * This Java program (FileExtensionFinder) takes a file name (a
 * String) as user input and displays the file extension, lowercased.
 *
 * @author Redacted McRedacted
 */
public class FileExtensionFinder {
    public static void main(String[] args) {
        Scanner sc = new Scanner(System.in);
        System.out.print("Enter your filename: ");
        String filename = sc.nextLine();
        sc.close();

        int periodIndex = filename.lastIndexOf('.');
        String extension = filename.substring(periodIndex + 1);
        String lcExtension = extension.toLowerCase();

        System.out.println("Your file is a(n) " + lcExtension +  " file.");
    }
}
```

- Good high-level description
- Good variable names
- Good chunks – not doing too much in one line

Arrays

- Assigning one array variable to another ➔ both variables refer to the same array
  - Similar to Python

Arrays

- Assigning one array variable to another ➔ both variables refer to the same array
  - Similar to Python
- Draw picture of code:

```
int [] fibNums = {1, 1, 2, 3, 5, 8, 13};
int [] otherFibNums;

otherFibNums = fibNums;
otherFibNums[2] = 99;

System.out.println(otherFibNums[2]);
System.out.println(fibNums[2]);
```

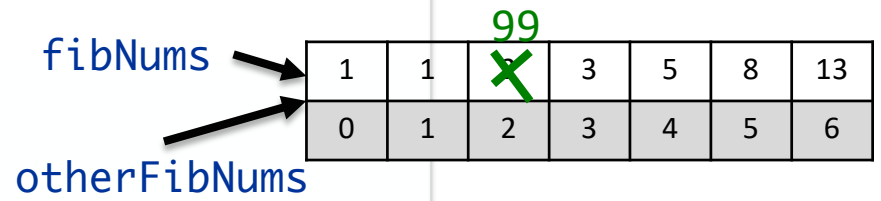
Arrays

- Assigning one array variable to another ➔ both variables refer to the same array
  - Similar to Python
- Draw picture of code:

```
int [] fibNums = {1, 1, 2, 3, 5, 8, 13};
int [] otherFibNums;

otherFibNums = fibNums;
otherFibNums[2] = 99;

System.out.println(otherFibNums[2]);
System.out.println(fibNums[2]);
```

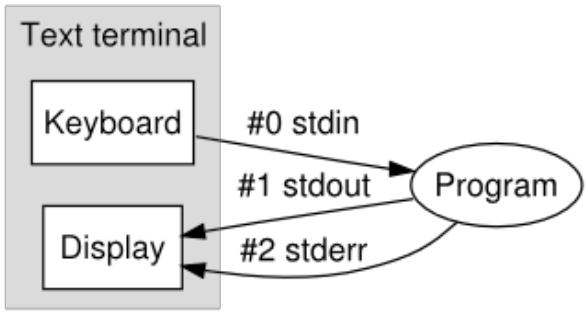


Displays:
99
99

STANDARD ERROR

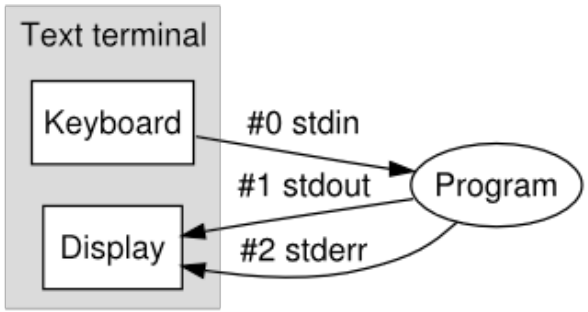
Standard Streams

- Preconnected streams
  - Standard Out: stdout
  - Standard In: stdin



Standard Streams

- Preconnected streams
  - Standard Out: stdout
  - Standard In: stdin
  - *Standard Error: stderr*
    - For error messages and diagnostics



Start thinking about the benefits
of two output streams (out and err)

Standard Streams: Java

- How we've been printing (to standard out)

```
System.out.println("Hello!");
```

- To print to standard error

```
System.err.println("Error Hello!");
```

Standard Streams: Python!

- Documentation for Python's `print` function:

```
print(...)
    print(value, ..., sep=' ', end='\n',
          file=sys.stdout, flush=False)
```

- `file` parameter says where to direct output
  - Default is to standard out

How could you print to standard error?

Standard Streams: Python!

- Documentation for Python's `print` function:

```
print(...)
    print(value, ..., sep=' ', end='\n',
          file=sys.stdout, flush=False)
```

- `file` parameter says where to direct output

```
import sys
print("Hello!")
print("Error Hello!", file=sys.stderr)
```

Redirecting Output

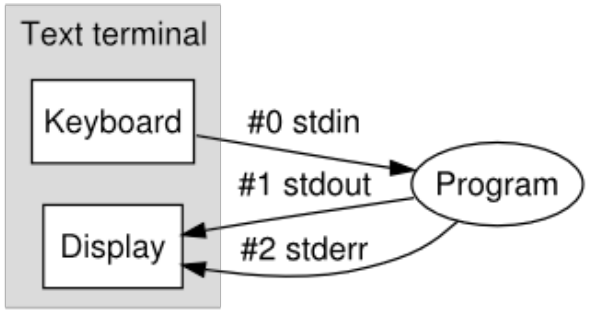
What is the benefit of having two output streams – output and error?

- Recall
```
$ java Assign1 > debugged.out
```
  - redirected `stdout` to `debugged.out`
  - `stderr` would still go to terminal
- To redirect `stderr` to same file as well:
```
$ java Assign1 1> debugged.out 2>&1
```
- To send stderr to another file:
```
$ java Assign1 1> debugged.out 2> debugged.err
```


StandardStreamsExample.java

Benefits of Separate Output and Error Stream

- Separate *output* vs *error* messages!
  - Can save outputs in two different files, e.g., error.log vs output.log
  - IDEs (e.g., IDLE) differentiate between output (black text) and error (red text)

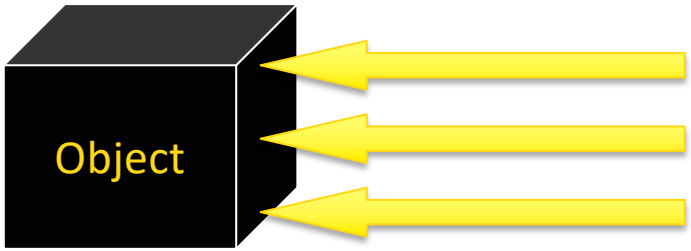


Review: Classes & Objects

- **Classes** define template from which objects are made
  - "Cookie cutters"
  - Define **state** (aka ***fields*** or ***attributes***)
  - Define **behavior**
- Many objects can be created of a class
  - Object: the cookie!
  - Ex: Many Mustangs created from Ford's "blueprint"
  - Object is an ***instance*** of the class
- **Constructor:** a special method that constructs and initializes an object
  - After construction, can call methods on object

Black-Box Programming

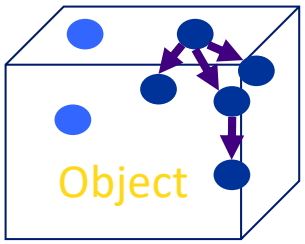
- ***How*** object does something doesn't matter
  - Example: if object *sorts*, does not matter to API user if implements merge or quick sort
- ***What*** object does matters (its **functionality**)
  - What object *exposes* to other objects
  - Referred to as **black-box programming** or **encapsulation**

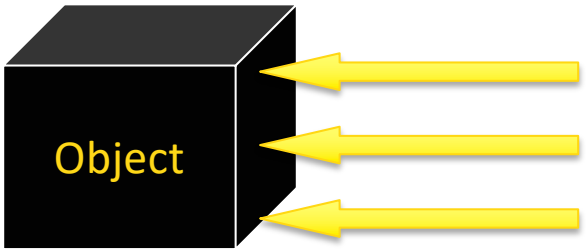


- Has public **interface** that others can use
- Hides state from others

Discussion

What is the problem with white-box programming?





Others can see and manipulate object's internals

- May have unintended consequences

Java's structure helps us enforce black-box programming

Java Access Modifiers

- A `public` method (or instance field) means that any object *of any class* can *directly call* the method (or access the field)
  - Least restrictive
- A `private` method (or instance field) means that any object *of the same class* can directly call this method (or access the field)
  - Most restrictive

- Additional access modifiers will be discussed with inheritance

In general, what access modifiers will we use for instance fields? For methods?

CREATING CLASSES

Classes and Objects

- Java is pure object-oriented programming
  - All data and methods in a program must be contained *within a class*

- But, for *data*, can use objects (e.g., `Strings` or `Scanners`) as well as primitive types (e.g., `int, double, char`)

General Java Class Structure

```
public class ClassName {

   // --------- INSTANCE VARIABLES ---------------
   // declare variables that represent object's state
   private int instVar;

   // --------- CONSTRUCTORS ---------------
   public ClassName() {
      // initialize data structures
   }

   // ----------- METHODS ------------
   public int getInfo() {
      return instVar;
   }
}
```

Example: `Chicken` class

- State
  - Name, weight, height
- Behavior
  - Accessor methods
    - `getWeight, getHeight, getName`
    - Convention: “get” for “getter” methods
  - Mutator methods
    - `feed`: adds weight, height
    - `setName`
      - Convention: “set” for “setter” methods

Discussion: what data types for instance variables?

Instance Variables: Chicken.java

```
public class Chicken {

   // --------- INSTANCE VARIABLES ---------------
    private String name;
    private int height; // in cm
    private double weight; // in lbs
```

Instance variables are *declared*, with access modifier (`private`, in this case)

Constructor: Chicken.java

```
public class Chicken {

   // --------- INSTANCE VARIABLES ---------------
    private String name;
    private int height; // in cm
    private double weight; // in lbs

    // --------- CONSTRUCTORS --------------------
    public Chicken(String name, int h, double weight) {
        this.name = name;
        height = h;
        this.weight = weight;
    }
    …
```

Observations? Thoughts? Questions?

Constructor: Chicken.java

```
public class Chicken {

   // --------- INSTANCE VARIABLES ---------------
    private String name;
    private int height; // in cm

    // --------- CONSTRUCTORS ----------------
    public Chicken(String name, int h, double weight) {
        this.name = name;
        height = h;
        this.weight = weight;
        ...
```

Constructor name same as class's name

Type and name for each parameter

Don't *have* to use `this` when variables are unambiguous

Parameters don't need to be same names as instance var names

`this`: Special name for the constructed object, like `self` in Python (differentiate from parameters)

Constructors

- **Constructor:** a special method that constructs and initializes an object
  - Does not return anything
- A constructor has the same name as its class
- Like `__init__` in Python
- After construction, can call methods on object

Example: `Chicken` class

- State
  - Name, weight, height
- Behavior
  - Accessor methods
    - `getWeight, getHeight, getName`
    - Convention: "get" for "getter" methods
  - Mutator methods
    - `feed`: adds weight, height to this Chicken
    - `setName`

Discussion: What are the methods' **input** (parameters) and **output** (what is returned and its data type)?

Methods: Chicken.java

```
    private String name;
    private int height; // in cm
    private double weight; // in lbs

…

// --------- Getter Methods ---------------
    public String getName() {
        return this.name;
    }

// --------- Mutator Methods ---------------
    public void feed() {
         weight += .3;
         height += 1;
    }
…
```

Methods: Chicken.java

```
    …
// --------- Getter Methods ---------------
    public String getName() {
        return this.name;
    }

// --------- Mutator Methods --------------
    public void feed() {
        weight += .3;
        height += 1;
    }
    …
}
```

Type the method returns

Chicken object's instance variables

Recall: you don't *have* to use `this` when variables are unambiguous

Constructing objects

- Given the `Chicken` **constructor**

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

create a chicken with the following characteristics

- Name is “Fred”, weight is 2.0, height is 38

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

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…