CS 106A, Lecture 22
More Classes

suggested reading:

Java Ch. 6

Based on slides created by Keith Schwarz, Mehran Sahami, Eric Roberts, Stuart Reges, and others.

Plan for today

- Announcements
- Review: Classes
- toString
- this
- Practice: Employee
- Inheritance
- Recap

Learning Goals

- Know how to define our own variable types
- Know how to define variable types that inherit from other types
- Be able to write programs consisting of multiple classes

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Announcements

- Assignment 5 due/Assignment 6 out Monday
- Reminder: the 106A website's "Schedule" page has lots of neat stuff for each lecture!
  - Slides and suggested reading sections
  - Starter code and polished solutions for live-coded programs
  - CodeStepByStep practice problems
- Midterm regrade requests can be made on Gradescope until 1PM on Monday

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What Is A Class?

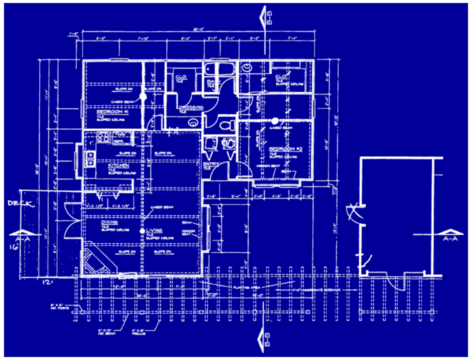
A class defines a new variable type.

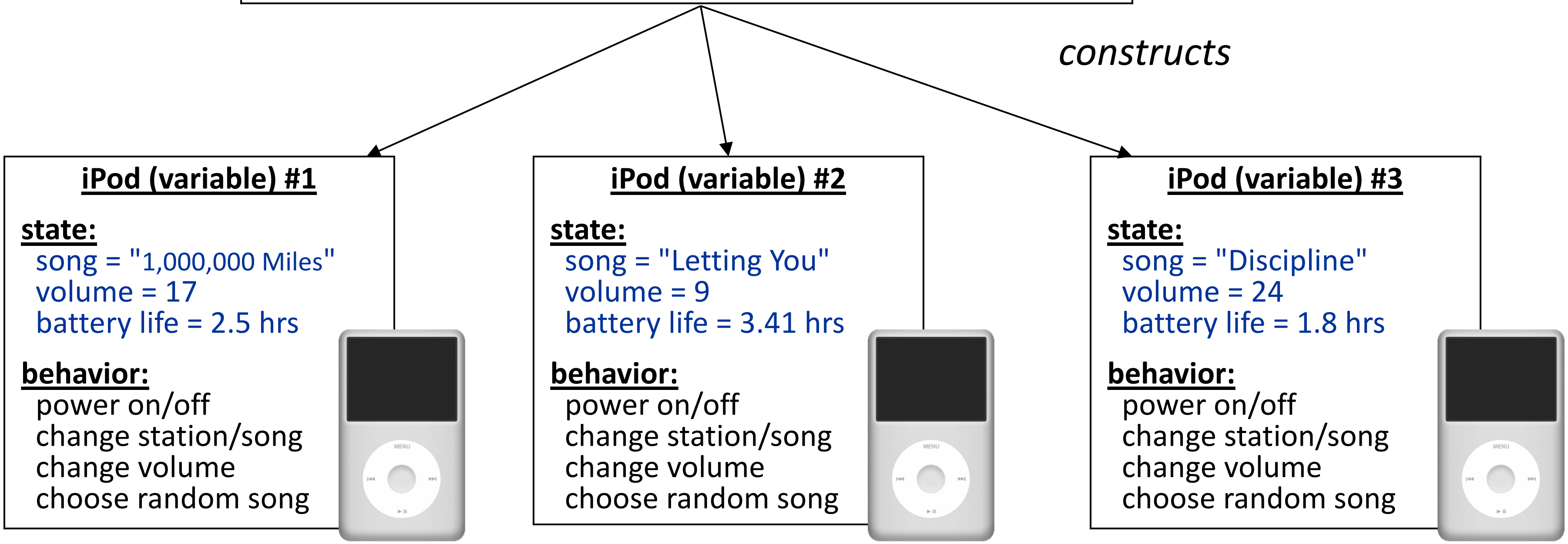
Classes Are Like Blueprints

iPod blueprint (class)

state:
current song
volume
battery life

behavior:
power on/off
change station/song
change volume
choose random song





constructs

iPod (variable) #1

state:
song = "1,000,000 Miles"
volume = 17
battery life = 2.5 hrs

behavior:
power on/off
change station/song
change volume
choose random song

iPod (variable) #2

state:
song = "Letting You"
volume = 9
battery life = 3.41 hrs

behavior:
power on/off
change station/song
change volume
choose random song

iPod (variable) #3

state:
song = "Discipline"
volume = 24
battery life = 1.8 hrs

behavior:
power on/off
change station/song
change volume
choose random song

Creating A New Class

1. **What information is inside this new variable type?**
   - These are its instance variables.
2. **How do you create a variable of this type?**
   - This is the constructor.
3. **What can this new variable type do?**
   - These are its public methods.

Example: BankAccount

Let’s see the code!

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Printing Variables

- By default, Java doesn't know how to print objects.

```
BankAccount ba1 = new BankAccount("Marty", 1.25);
println("ba1 is " + ba1); // ba1 is BankAccount@9e8c34

// better, but cumbersome to write
println("ba1 is " + ba1.getName() + " with $"
        + ba1.getBalance()); // ba1 is Marty with $1.25


// desired behavior
println("ba1 is " + ba1);   // ba1 is Marty with $1.25
```

The toString Method

A special method in a class that tells Java how to convert an object into a string.

```
BankAccount ba1 = new BankAccount("Marty", 1.25);
println("ba1 is " + ba1);

// the above code is really calling the following:
println("ba1 is " + ba1.toString());
```

- Every class has a `toString`, even if it isn't in your code.
  - Default: class's name @ object's memory address (base 16)

```
BankAccount@9e8c34
```

The toString Method

```
public String toString() {
    code that returns a String
    representing this object;
}
```

- Method name, return, and parameters must match exactly.

- Example:

```
// Returns a String representing this account.
public String toString() {
    return name + " has $" + balance;
}
```

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The “this” Keyword

this: Refers to the object on which a method is currently being called

```
BankAccount ba1 = new BankAccount();
ba1.deposit(5);

// in BankAccount.java
public void deposit(double amount) {
     // for code above, “this” -> ba1
     ...
}
```

Using “this”

Sometimes we want to name parameters the same as instance variables.

```
public class BankAccount {
    private double balance;
    private String name;
    ...

    public void setName(String newName) {
        name = newName;
    }
}
```

- Here, the parameter to `setName` is named newName to be distinct from the object's field name .

Using “this”

```
public class BankAccount {
    private double balance;
    private String name;
    ...

    public void setName(String name) {
        name = name;
    }
}
```

Using “this”

We can use “this” to specify which one is the instance variable and which one is the local variable.

```
public class BankAccount {
    private double balance;
    private String name;
    ...

    public void setName(String name) {
        this.name = name;
    }
}
```

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Practice: Employee

Let’s define a new variable type called **Employee** that represents a single Employee.

What information would an Employee store?

How would you create a new Employee variable?

What could an Employee do?

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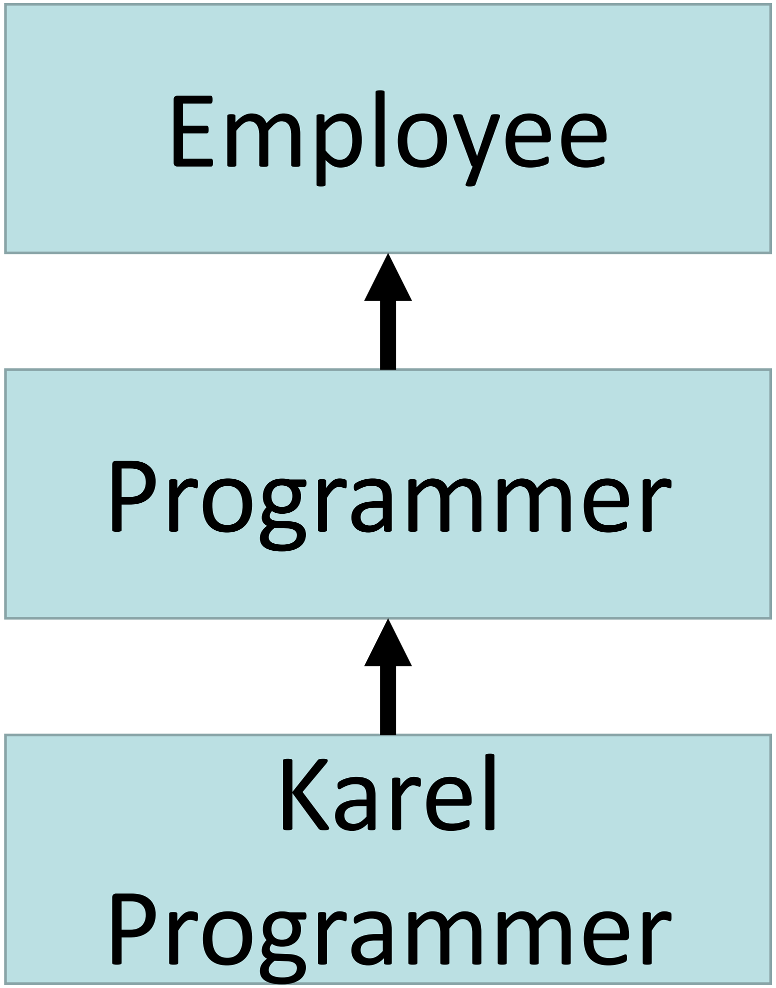
Inheritance

Inheritance lets us relate our variable types to one another.

Inheritance



Employee

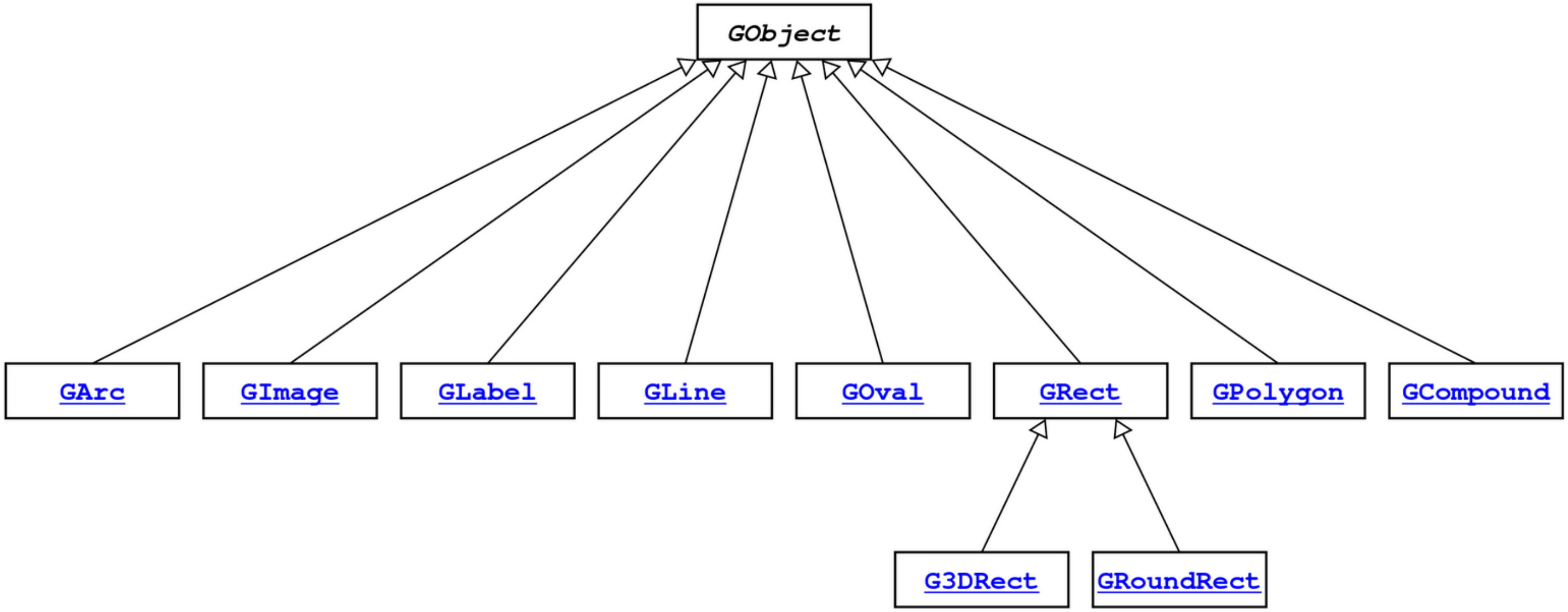
Programmer

Karel Programmer

Variable types can seem to “inherit” from one other. We don’t want to have to duplicate code for each one!

Example: GObjects

- The Stanford library uses an inheritance hierarchy of graphical objects based on a common superclass named **`GObject`**.



Example: GObjects

- **GObject** defines the state and behavior common to all shapes:

  contains(***x***, ***y***)
  getColor(), setColor(***color***)
  getHeight(), getWidth(), getLocation(), setLocation(***x***, ***y***)
  getX(), getY(), setX(***x***), setY(***y***), move(***dx***, ***dy***)
  setVisible(***visible***), sendForward(), sendBackward()
  toString()

- The subclasses add state and behavior unique to them:

GLabel

get/setFont
get/setLabel

...

GLine

get/setStartPoint
get/setEndPoint

...

GPolygon

addEdge
addVertex
get/setFillColor

..

Using Inheritance

```
public class Name extends Superclass {
```

- Example:

```
public class Programmer extends Employee {
    ...
}
```

- By extending Employee, this tells Java that `Programmer` can do **everything an Employee can do, plus more**.
- Programmer automatically inherits all of the code from Employee!
- The **superclass** is Employee, the **subclass** is Programmer.

Example: Programmer

```
public class Programmer extends Employee {
     private int timeCoding;
     ...
     public void code() {
           timeCoding += 10;
     }
}

...

Programmer annie = new Programmer(“Annie”);
annie.code();         // from Programmer
annie.promote();      // from Employee!
```

Example: KarelProgrammer

```
public class KarelProgrammer extends Programmer {
    private int numBeepersPicked;
    ...
    public void pickBeepers() {
        numBeepersPicked += 2;
    }
}

...
KarelProgrammer colin = new KarelProgrammer(“Colin”);
colin.pickBeepers();         // from KarelProgrammer
colin.code();                // from Programmer!
colin.promote();             // From Employee!
```

Advanced: Overriding

```
public class KarelProgrammer extends Programmer {
     ...

     @Override
     public boolean promote() {
          salary *= 3;
          return true;
     }
}

...
KarelProgrammer colin = new KarelProgrammer(“Colin”);
colin.promote();     // From KarelProgrammer, not Employee!
```

Advanced: Overriding

```java
public class Clicker extends GraphicsProgram {
    ...

    @Override
    public void mouseClicked(MouseEvent e) {
        // do some stuff
    }
}
```

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Recap

- Classes let us define our own variable types, with their own instance variables, methods and constructors.
- We can **relate** our variable types to one another by using **inheritance**. One class can **extend** another to inherit its behavior.
- We can **extend GCanvas** in a graphical program to decompose all of our graphics-related code in one place.

Next time: Interactors and GUIs