- Previous Lecture:
  - Iteration—the **`for`** loop
  - **`String`** objects
- Today's Lecture:

  Object oriented programming
  - Objects and classes
  - Variables
  - Methods
  - Modifiers
- Reading (JV): Sec 4.1-4.3

Motivation

- Suppose the states of a bank account is represented by some variables:

```
// bank account
int balance;   // current balance
int deposits;  // deposits to date
int withdrawals;  // wd to date
```

- Shortcomings:
  - Relationships among variables are not made explicit
  - Scale: if we want 2 bank accounts, then we write twice as much code:

```
// bank account 1
   int balance1;
   int deposits1;
   int withdrawals1;
// bank account 2
   int balance 2;
   int deposits2;
   int withdrawals2;
```


Aggregation

- Group variables into a new *abstraction* that makes their relationship to one another explicit
  - Such an abstraction is called a ***class***
  - Abstraction: a named compound thing that can be manipulated as a unit
  - Example: a class **`Account`**
- Scale: create multiple instances of the abstraction
  - Each instance of the abstraction is called an ***object***
  - Example: refer to the two accounts as **`account1`** and **`account2`**

Terminology and conepts

- ***Object***: contains variables (fields, instance variables) and methods
  - ***Variables***: "state" or "characteristics"
    e.g., name, age
  - ***Methods***: "behavior" or "action"
    e.g., yell, bounce
- ***Class***: blueprint (definition) of an object
  - *No memory space* is reserved for object data
- Imagine a class `Cookie`. To make a whole lot of cookies, you may want to
  - Make a cookie cutter—*define the class*
  - Need to actually stamp out the cookie—*instantiate an object*
  - Note that *class definition* $\neq$ *object instantiation*

Variables

TWO main types of variables:

- Primitive type
- Reference to object

Some variables with different properties:

- ***Local***: live and die inside a method
- ***Instance* variable**: owned by and accessed through individual instances (objects)
- ***Static* variable**: *class* variable shared by all instances—only *one* copy in a class

Class Definition

```
public class class-name {

    declaration (and initialization)

    constructor

    methods

}
```


Class definitions: declarations

```
public class Account {
   private int balance;  // current bal.
   private int deposits; // deposits to
                         // date
   private int withdrawals; //withdrawal
                            //to date
}
```

- *Declarations* of a class define ***fields*** (***instance variables***) of the class
- Each class is a *type*. Classes are not primitive types.

Variables and values revisited

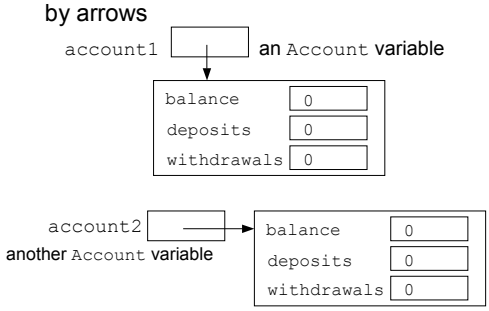
- *Variable*: named place to hold a value

  name | *value*

- Values of primitive types are held directly in variables

  `count` | `0` an `int` variable

- Values of non-primitive types are *references to objects* shown graphically by arrows



Declarations Revisited

- Syntax: *type name;*
- Examples:

```
int count;
Account account1;
Account account2;
```

- Instance variables have default initial values
  - `int` variables: `0`
  - Non-primitive (reference) variables: **`null`**
- Value `null` signifies that no object is referenced

Declaration and object instantiation (initialization)

- Syntax: *type name* = *expression*;
- Examples:

```
int count = 0;
Account account1 = new Account();
Account account2 = new Account();
```

Object instantiation:

- An expression of the form

  `new` ***class-name*`()`**

  computes a reference to a newly created object of the given class

Manipulating a field of an object

- Let **`f`** be a field defined for class **`c`**
- Let **`r`** refer to an object ***o*** of class **`c`**
- Then **`r.f`** is a variable of object ***o***
- The dot (`.`) means "follow the arrow"
- Example:

```
// deposit d into account1
account1.balance = account1.balance + d;
account1.deposits=account1.deposits + d;

// shortcut
account1.balance += d;
account1.deposits += d;
```

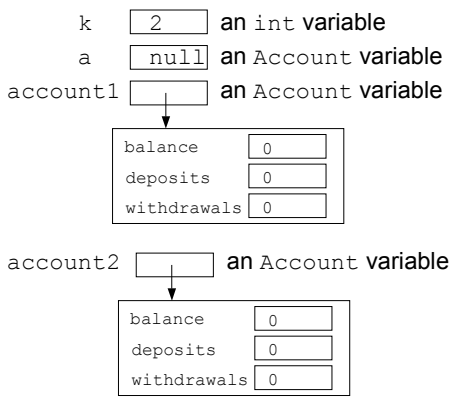

References are values

- Suppose you declare `a` to be an `Account` reference variable:

  `Account a;`
- Then you can assign an reference to an `Account` object into variable `a`
- Example:

```
// if k is 1, deposit d into account1
// otherwise deposit d into account2
   if (k==1)
      a = account1;
   else
      a = account2;
   // deposit d to Account a
   a.balance = a.balance + d;
   a.deposits = a.deposits + d;
```


References are values, cont'd



Methods

A method is a named, parameterized group of statements

Syntax

```
return-type method-name ( parameter-list ) {
    statement-list
}
```

return-type `void` means nothing is returned from the method

Example class definition

```
public class Account {
   private int balance;  // current bal.
   private int deposits; // deposits to
                         // date
   private int withdrawals; //withdrawal
                            //to date

   // deposit d to account
   public void deposit(int d) {
      balance = balance + d;
      deposits = deposits + d;
   }

   // withdraw w from account
   public void withdraw(int w) {
      balance -= w;
      withdrawals += w;
   }
}
```