Objects, Classes, and Packages

- “Static” Classes
- Introduction to Classes
- Object Variables and Object References
- Instantiating Objects
- Using Methods in Objects
- Reading for this Lecture: L&L, 3.1 - 3.3
- Familiarize yourself with Sun Website as a reference for the Java Class Library

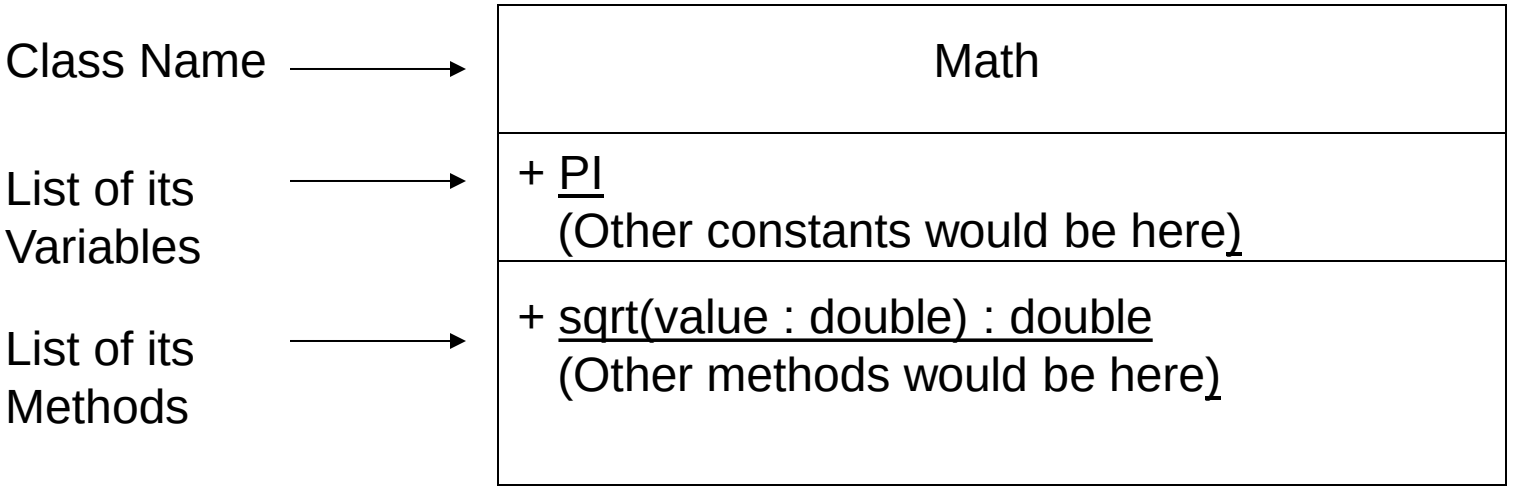
“Static” Classes

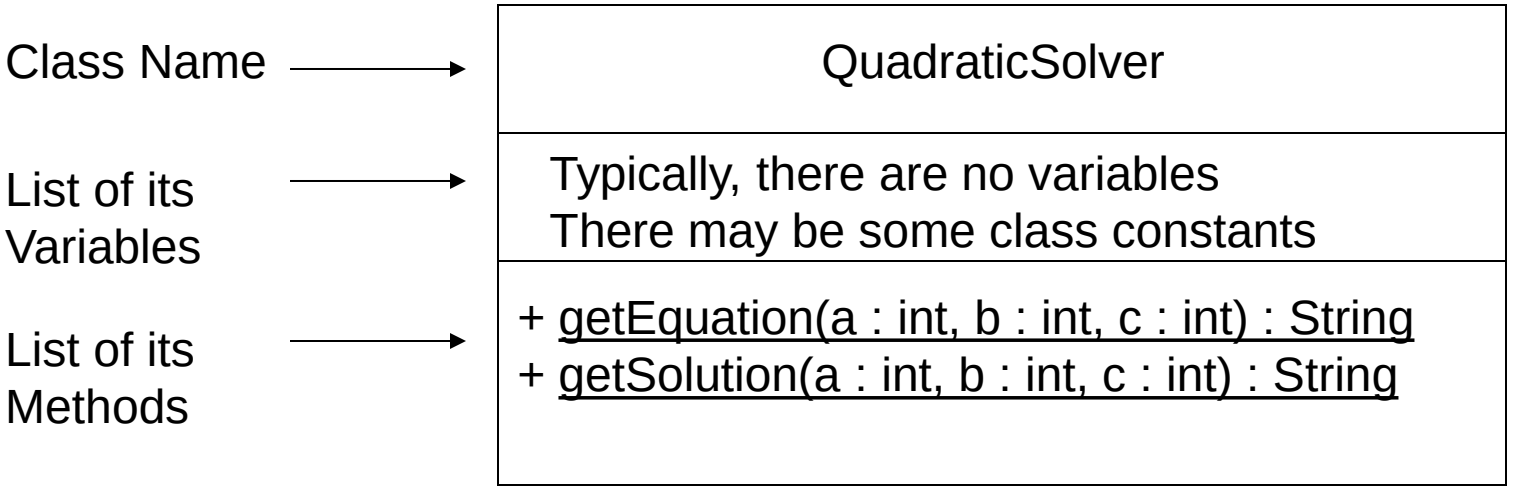
- A class that has static members only – both attributes and methods is a “static” class
- We do not instantiate any objects of that class
- We use the class name to access its members
- Examples:
  - Math class

    Math.sqrt(doubleValue) or Math.PI
  - QuadraticSolver class in Project 1

    QuadraticSolver.getSolution()

“Static” Classes





“Static” classes

- In such a class, we define attributes and methods including the reserved word static
- Examples:
  - In the Math class source code

    public static final double PI = 3.14…..;

    public static double sqrt(double input) { }
  - In the QuadraticSolver source code

    public static String getEquation(int a, int b, int c) { }

    public static String getSolution(int a, int b, int c) { }

“Static” Classes

- Although this is a valid way to break a Java program into smaller pieces, it is not the true intent of Object-Oriented Programming (OOP)
- It is more like procedural programming (e.g. C)
- In true OOP, we:
  - Use classes to encapsulate data and use methods to define the valid operations on that data
  - Instantiate objects from the classes and access methods using object names – not class names

Introduction to Classes

- A class defines the attributes and behavior of a specific type of object
  - Attributes are variables declared in the class
  - Behaviors are methods defined in the class
- Normally, we access an object by calling a method defined by its class
- We may sometimes access an attribute defined by its class, but this is discouraged

“Classifying” into Classes

- To understand the context of the word “class” in Java, think about the word “classify”
- Classes “classify” different “objects” based on the similarities in attributes and behaviors
- The desks, chairs, and tables in this room can be classified as “Furniture” class objects
- There’s a sense of common attributes and behaviors that all “Furniture” objects share

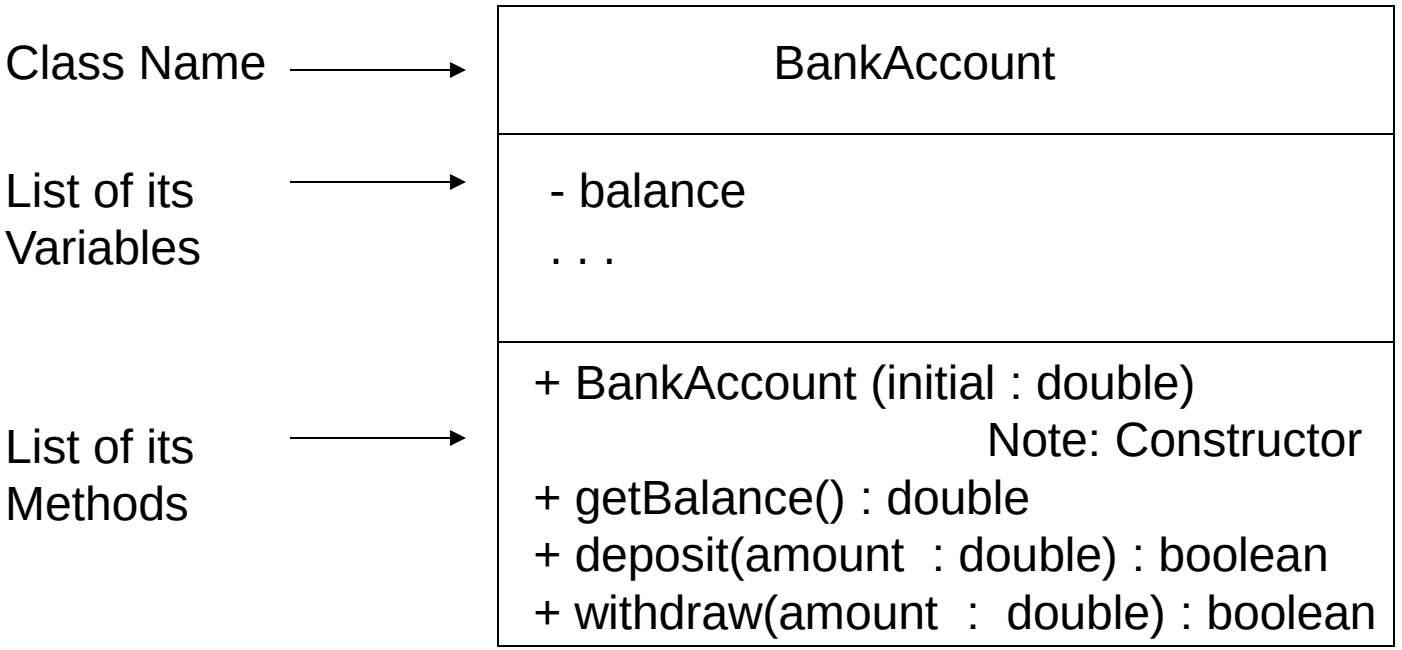
Introduction to Classes

- A class has a name that we can use as if it were a data type when declaring a variable
- When we declare a variable with the name of a class as its type, we are creating a reference variable (It can contain a reference to an object)
- We access an object's methods / attributes using the reference variable name and the **.** notation, e.g.

```
ClassName objectName;   //reference variable
objectName.methodName() // Note the ( )
objectName.variableName // Note no  ( )
```

Example of a Class Definition

- We can draw a diagram of a class to outline its important features before writing code – its name, attributes, and behaviors



Example of a Class Definition

```
public class BankAccount {
  // an attribute or variable
  private double balance;

  // the constructor method
  public BankAccount(double initial)
  {
     balance = initial;
  }
```

Example of a Class Definition

```
    // other behaviors or normal methods

    public double getBalance()
    {
        return balance;
    }
   public boolean deposit(double amount)
   {
       balance += amount;
       return true;
   }
      // additional behaviors or methods
}     // end of class definition
```

Creating Objects

- To declare a variable as a *reference* to a BankAccount object, we use the class name as the type name

```
BankAccount myAccount;
```

- This declaration does not create an object
- It only creates a reference variable that can hold a reference to a BankAccount object

Example of a Class Definition

- Declaring a BankAccount object:

```
BankAccount myAccount =
      new BankAccount(100.00); //constructor
```

- Accessing other BankAccount methods:

```
boolean status = myAccount.deposit(50.00);
double myMoney = myAccount.getBalance();
```

- Why can't we just do this?

```
myAccount.balance += 50.00;
```

Prototype for a Class Definition

- We use the Java reserved word *private* to prevent access to a variable or method from code that is written outside the class
- We use the Java reserved word *public* to allow access to a variable or method from code that is written outside the class
- Normally, we declare variables to be *private*
- Normally, we declare methods to be *public*
- We will see some valid exceptions later

Creating Objects

- We use the `new` operator to create an object

```
BankAccount myAccount = new BankAccount(100.00);
```

Instantiation operator

This calls the BankAccount *constructor*, which is a special method that initializes the object

- Creating an object is called *instantiation*
- An object is an *instance* of a particular class
- `myAccount` is assigned a reference to an object of type BankAccount that encapsulates the balance

Invoking Methods

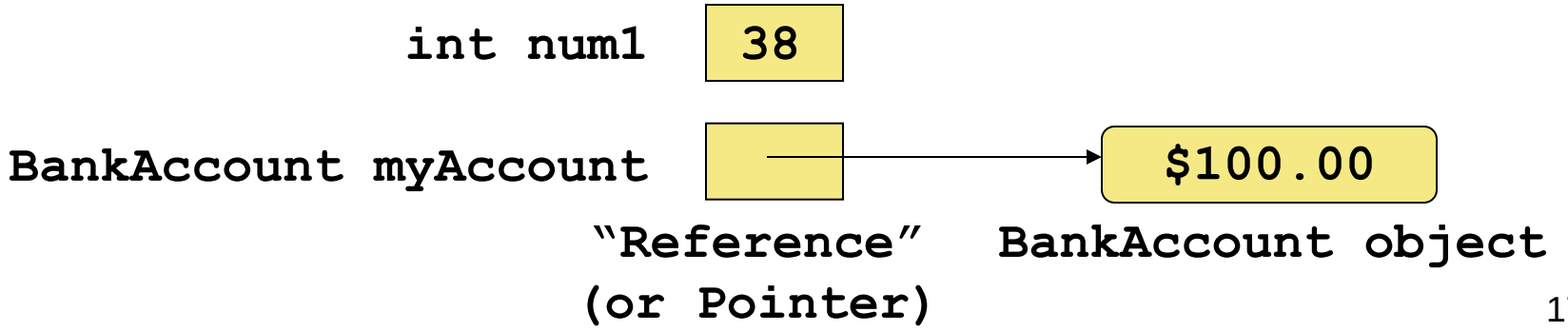
- Once an object has been instantiated, we can use the *dot operator* to invoke or "call" any of the object's methods

```
double myMoney =
        myAccount.getBalance();
```

- A method invocation can be thought of as:
  - Asking an object to perform a service OR
  - Doing something to the state of the object

References

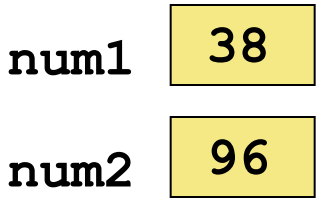
- A primitive variable contains the value itself, but a reference variable contains an object reference
- An object reference can be thought of as a pointer to the location of the object in memory
- Rather than dealing with arbitrary address values, we often depict a reference graphically



Assignment Revisited

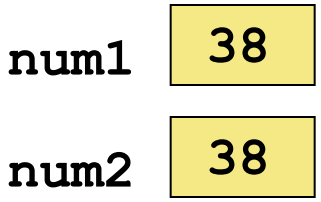
- The act of assignment takes a copy of a value and stores it in a variable
- For primitive types:

Before:




```
num2 = num1;
```

After:



Reference Assignment

- For object references, assignment copies the reference:

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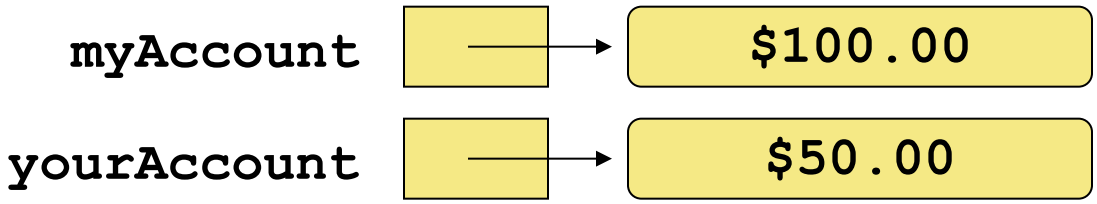
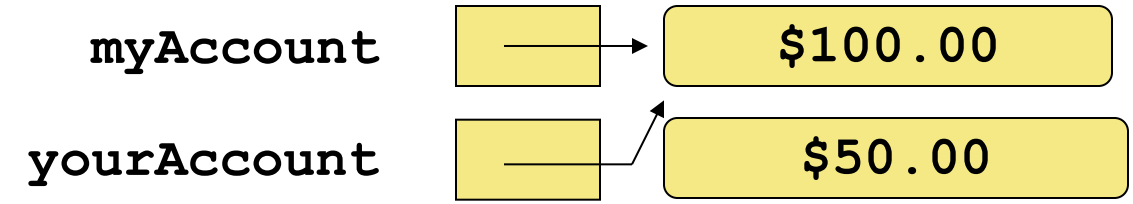



```
if (myAccount == yourAccount)  // note use of ==
  System.out.println("The Same");  // no
yourAccount = myAccount;
```

After:



Garbage: See later slide

```
if(myAccount == yourAccount)
  System.out.println("The Same");  //yes
```

Aliases

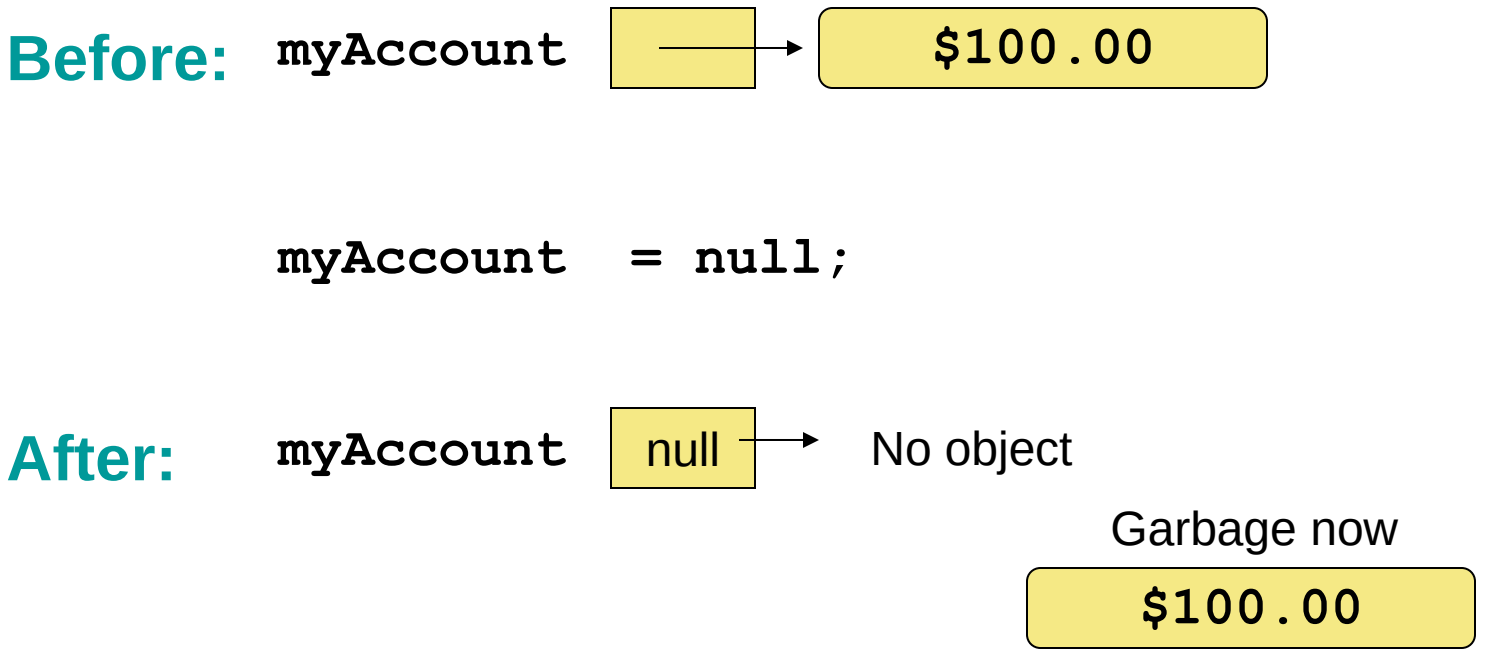
- Two or more references that refer to the same object are called *aliases* of each other
- One object can be accessed using more than one reference variable
- Changing an object via one reference variable changes it for all of its aliases, because there is really only one object
- Aliases can be useful, but should be managed carefully (Do you want me to be able to withdraw money from your account? I doubt it!)

Garbage Collection

- When there are no longer any variables containing a reference to an object (e.g. the $50.00 on the earlier slide), the program can no longer access it
- The object is useless and is considered *garbage*
- Periodically, Java performs *automatic garbage collection* and returns an object's memory to the system for future use
- In other languages such as C/C++, the programmer must write explicit code to do the garbage collection

Garbage Collection

- Setting reference variable's value to null, makes the object garbage (unavailable):



Garbage Collection

- If a reference variable's value is equal to null, any reference to an attribute or method of that object will cause your program to fail.

```
myAccount = new BankAccount(100.00);

System.out.println(myAccount.balance());  // OK

myAccount = null;   // $100 BankAccount => garbage

System.out.println(myAccount.balance());  // Fails
```