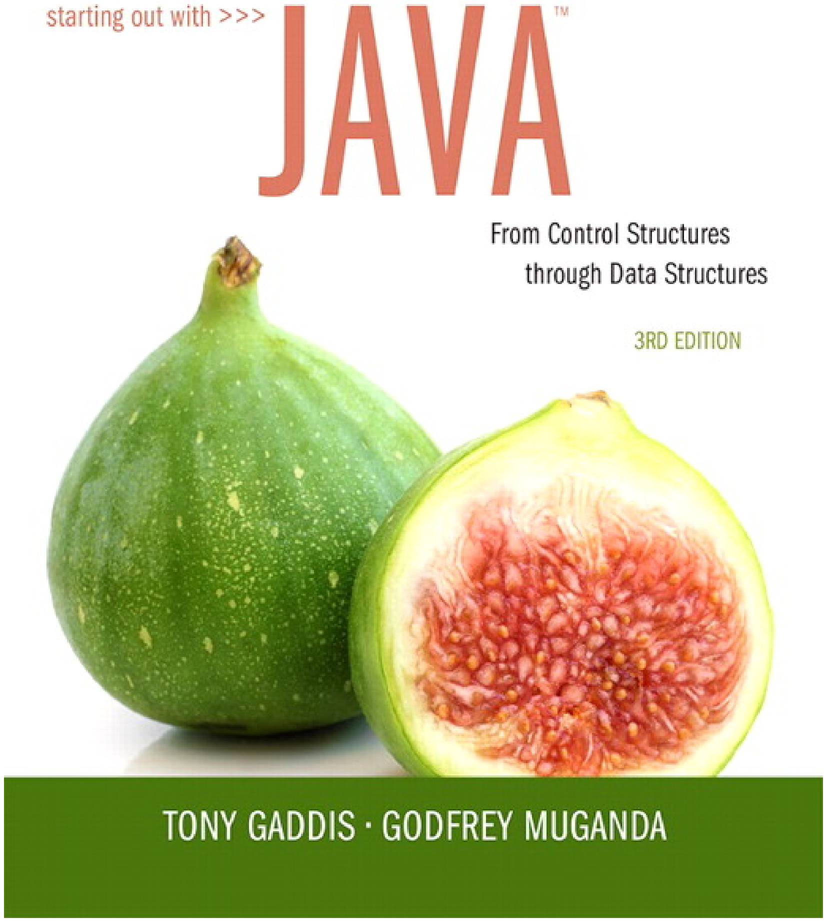
CHAPTER 8

A Second Look at Classes and Objects



starting out with >>> JAVA™

From Control Structures through Data Structures

3RD EDITION

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Chapter Topics

Chapter 8 discusses the following main topics:

- Static Class Members
- Passing Objects as Arguments to Methods
- Returning Objects from Methods
- The `toString` method
- Writing an `equals` Method
- Methods that Copy Objects

Chapter Topics

Chapter 8 discusses the following main topics:

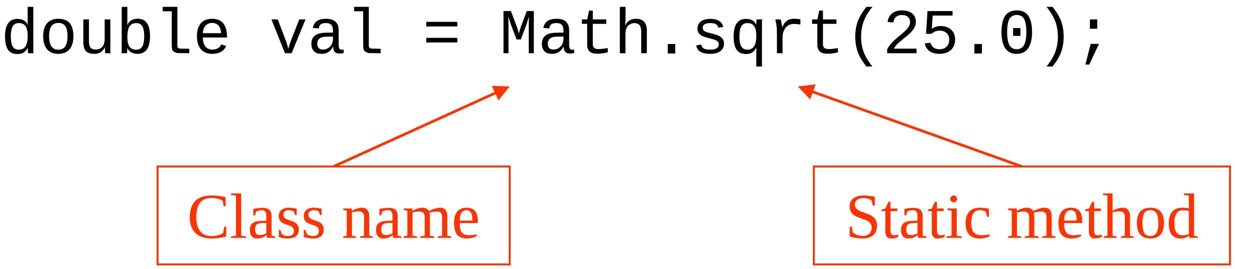
- Aggregation
- The `this` Reference Variable
- Enumerated Types
- Garbage Collection
- Focus on Object-Oriented Design: Class Collaboration

Review of Instance Fields and Methods

- Each instance of a class has its own copy of instance variables.
  - Example:
    - The `Rectangle` class defines a `length` and a `width` field.
    - Each instance of the `Rectangle` class can have different values stored in its `length` and `width` fields.
- Instance methods require that an instance of a class be created in order to be used.
- Instance methods typically interact with instance fields or calculate values based on those fields.

Static Class Members

- *Static fields* and *static methods* do not belong to a single instance of a class.
- To invoke a static method or use a static field, the class name, rather than the instance name, is used.
- Example:



```
double val = Math.sqrt(25.0);
```

Static Fields

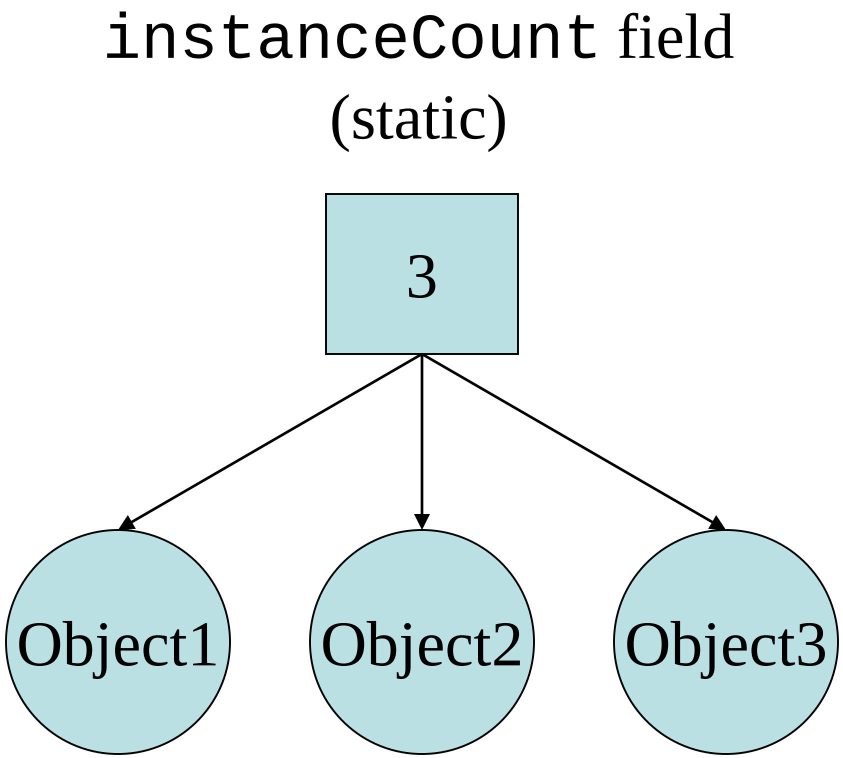
- Class fields are declared using the `static` keyword between the access specifier and the field type.

```
private static int instanceCount = 0;
```

- The field is initialized to 0 only once, regardless of the number of times the class is instantiated.
  - Primitive static fields are initialized to 0 if no initialization is performed.

- Examples: Countable.java, StaticDemo.java

Static Fields



`instanceCount` field

(static)

3

Object1

Object2

Object3

Static Methods

- Methods can also be declared static by placing the `static` keyword between the access modifier and the return type of the method.

```
public static double milesToKilometers(double miles)
{…}
```

- When a class contains a static method, it is not necessary to create an instance of the class in order to use the method.

```
double kilosPerMile = Metric.milesToKilometers(1.0);
```

- Examples: Metric.java, MetricDemo.java

Static Methods

- Static methods are convenient because they may be called at the class level.
- They are typically used to create utility classes, such as the `Math` class in the Java Standard Library.
- Static methods may not communicate with instance fields, only static fields.

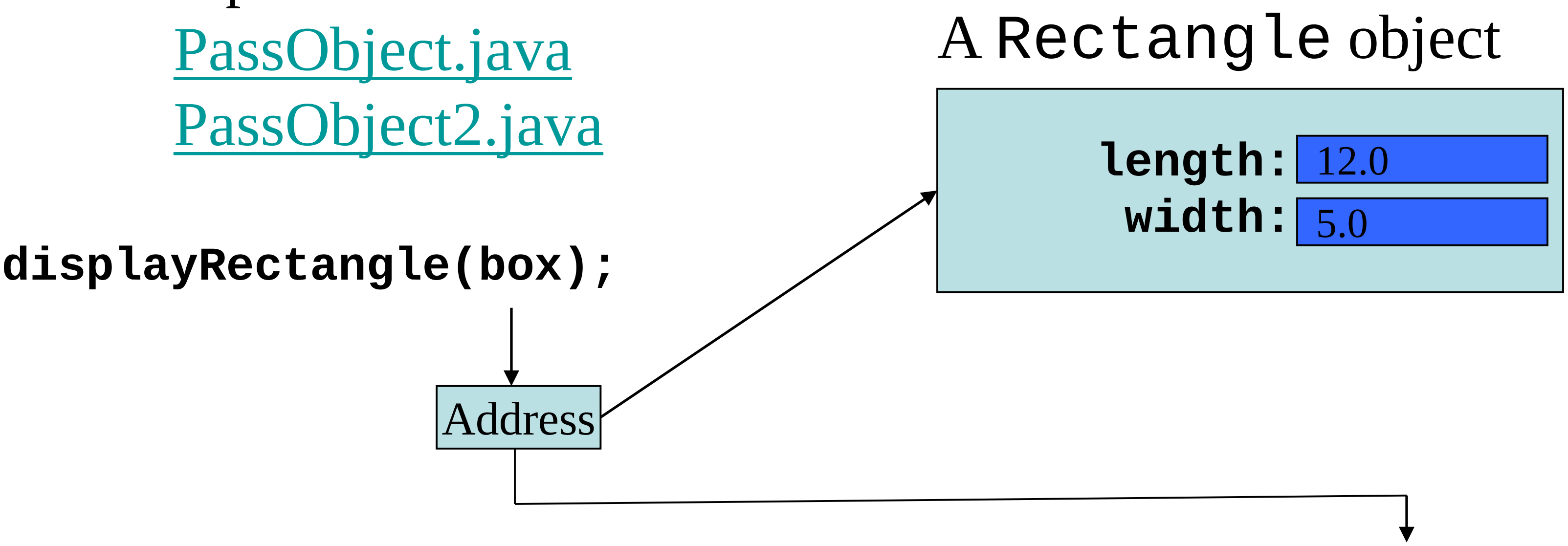
Passing Objects as Arguments

- Objects can be passed to methods as arguments.
- Java passes all arguments *by value*.
- When an object is passed as an argument, the value of the reference variable is passed.
- The value of the reference variable is an address or reference to the object in memory.
- A *copy* of the object is *not passed*, just a pointer to the object.
- When a method receives a reference variable as an argument, it is possible for the method to modify the contents of the object referenced by the variable.

Passing Objects as Arguments

Examples:

- PassObject.java
- PassObject2.java



```
displayRectangle(box);
```

```
public static void displayRectangle(Rectangle r)
{
  // Display the length and width.
  System.out.println("Length: " + r.getLength() +
                     " Width: " + r.getWidth());
}
```

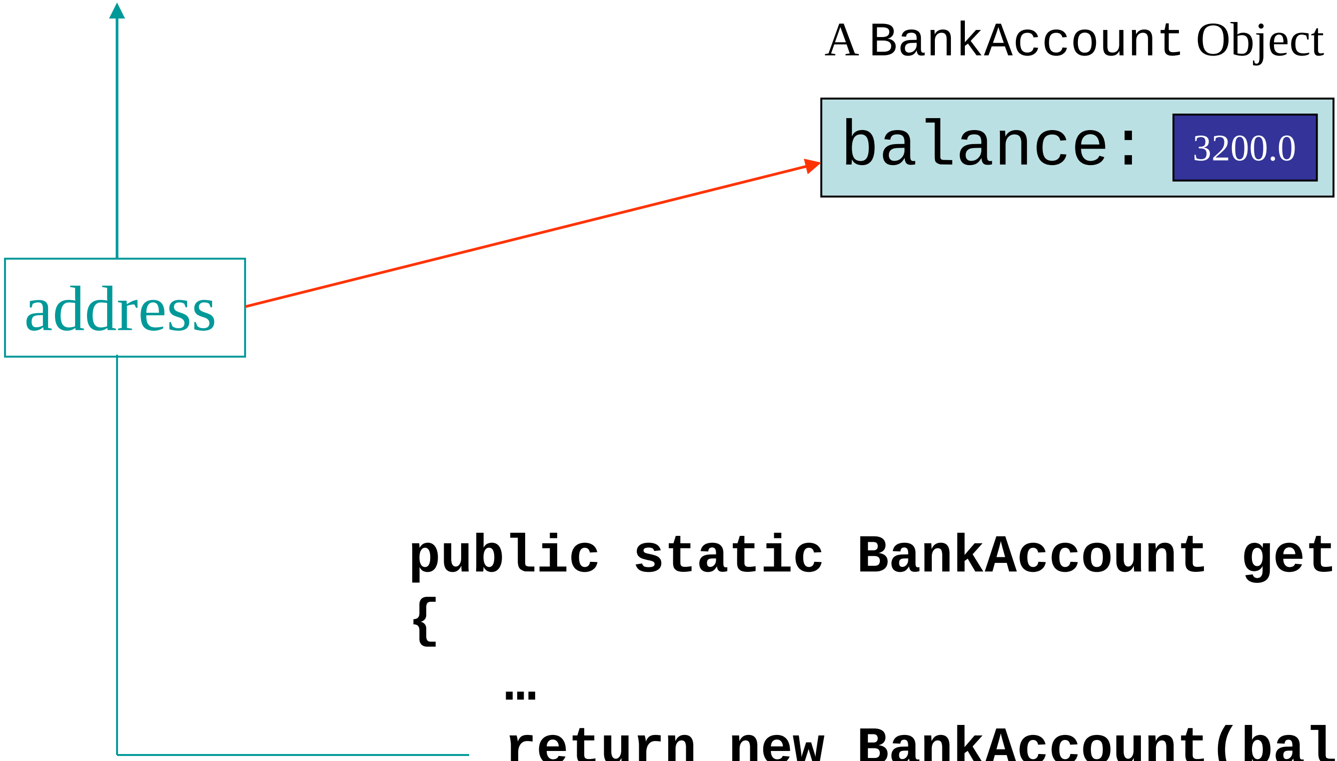
Returning Objects From Methods

- Methods are not limited to returning the primitive data types.
- Methods can return references to objects as well.
- Just as with passing arguments, a copy of the object is **not** returned, only its address.
- See example: ReturnObject.java
- Method return type:

```
public static BankAccount getAccount()
{
     …
      return new BankAccount(balance);
}
```

Returning Objects from Methods

```
account = getAccount();
```



A BankAccount Object

balance: 3200.0

address

```
public static BankAccount getAccount()
{
   …
   return new BankAccount(balance);
}
```

The `toString` Method

- The `toString` method of a class can be called *explicitly*:

```
 Stock xyzCompany = new Stock ("XYZ", 9.62);
 System.out.println(xyzCompany.toString());
```

- However, the `toString` method does not have to be called explicitly but is called implicitly whenever you pass an object of the class to `println` or `print`.

```
Stock xyzCompany = new Stock ("XYZ", 9.62);
System.out.println(xyzCompany);
```

The `toString` method

- The `toString` method is also called implicitly whenever you concatenate an object of the class with a string.

```
Stock xyzCompany = new Stock ("XYZ", 9.62);
System.out.println("The stock data is:\n" +
   xyzCompany);
```

The `toString` Method

- All objects have a `toString` method that returns the class name and a hash of the memory address of the object.
- We can override the default method with our own to print out more useful information.
- Examples: Stock.java, StockDemo1.java

The `equals` Method

- When the `==` operator is used with reference variables, the memory address of the objects are compared.
- The contents of the objects are not compared.
- All objects have an `equals` method.
- The default operation of the `equals` method is to compare memory addresses of the objects (just like the `==` operator).

The `equals` Method

- The `Stock` class has an `equals` method.
- If we try the following:

```
Stock stock1 = new Stock("GMX", 55.3);
Stock stock2 = new Stock("GMX", 55.3);
if (stock1 == stock2) // This is a mistake.
  System.out.println("The objects are the same.");
else
  System.out.println("The objects are not the same.");
```

only the addresses of the objects are compared.

The `equals` Method

- Instead of using the `==` operator to compare two `Stock` objects, we should use the `equals` method.

```
public boolean equals(Stock object2)
{
   boolean status;

   if(symbol.equals(Object2.symbol && sharePrice == Object2.sharePrice)
      status = true;
   else
      status = false;
   return status;
}
```

- Now, objects can be compared by their contents rather than by their memory addresses.
- See example: StockCompare.java

Methods That Copy Objects

- There are two ways to copy an object.
  - You cannot use the assignment operator to copy reference types
  - Reference only copy
    - This is simply copying the address of an object into another reference variable.
  - Deep copy (correct)
    - This involves creating a new instance of the class and copying the values from one object into the new object.
  - Example: ObjectCopy.java

Copy Constructors

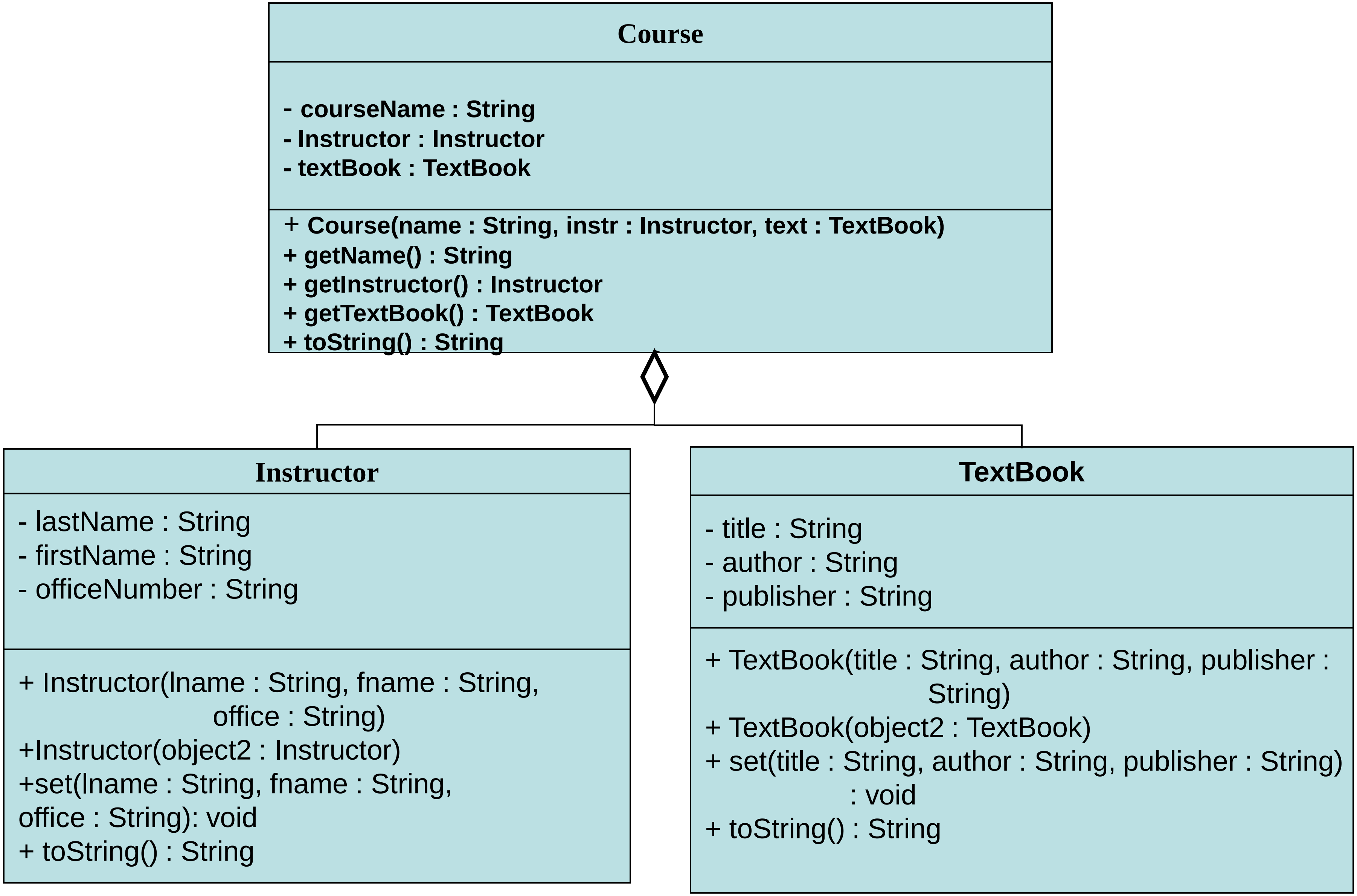
- A copy constructor accepts an existing object of the same class and clones it

```
public Stock(Stock object 2)
{
    symbol = object2.symbol;
    sharePrice = object2.sharePrice;
}

// Create a Stock object
Stock company1 = new Stock("XYZ", 9.62);

//Create company2, a copy of company1
Stock company2 = new Stock(company1);
```

Aggregation

- Creating an instance of one class as a reference in another class is called *object aggregation*.
- Aggregation creates a "has a" relationship between objects.
- Examples:
  - Instructor.java, Textbook.java, Course.java, CourseDemo.java

Aggregation in UML Diagrams



Course

- courseName : String
- Instructor : Instructor
- textBook : TextBook

+ Course(name : String, instr : Instructor, text : TextBook)
+ getName() : String
+ getInstructor() : Instructor
+ getTextBook() : TextBook
+ toString() : String

Instructor

- lastName : String
- firstName : String
- officeNumber : String

+ Instructor(lname : String, fname : String,
office : String)
+Instructor(object2 : Instructor)
+set(lname : String, fname : String,
office : String): void
+ toString() : String

TextBook

- title : String
- author : String
- publisher : String

+ TextBook(title : String, author : String, publisher :
String)
+ TextBook(object2 : TextBook)
+ set(title : String, author : String, publisher : String)
: void
+ toString() : String

Returning References to Private Fields

- Avoid returning references to private data elements.
- Returning references to private variables will allow any object that receives the reference to modify the variable.

Null References

- A *null reference* is a reference variable that points to nothing.
- If a reference is null, then no operations can be performed on it.
- References can be tested to see if they point to null prior to being used.

```
if(name != null)
{
  System.out.println("Name is: "
                     + name.toUpperCase());
}
```

- Examples: FullName.java, NameTester.java

The this Reference

- The `this` reference is simply a name that an object can use to refer to itself.
- The `this` reference can be used to overcome shadowing and allow a parameter to have the same name as an instance field.

```
public void setFeet(int feet)
{
  this.feet = feet;
  //sets the this instance’s feet field
  //equal to the parameter feet.
}
```

Local parameter variable feet

Shadowed instance variable

The this Reference

- The `this` reference can be used to call a constructor from another constructor.

  ```
  public Stock(String sym)
  {
     this(sym, 0.0);
  }
  ```

  - This constructor would allow an instance of the `Stock` class to be created using only the symbol name as a parameter.
  - It calls the constructor that takes the symbol and the price, using *sym* as the symbol argument and 0 as the price argument.
- Elaborate constructor chaining can be created using this technique.
- If `this` is used in a constructor, it must be the first statement in the constructor.

Enumerated Types

- Known as an `enum`, requires declaration and definition like a class
- Syntax:
  `enum` *`typeName`* `{` *one or more enum constants* `}`
  - Definition:

```
enum Day { SUNDAY, MONDAY, TUESDAY, WEDNESDAY, THURSDAY,
           FRIDAY, SATURDAY }
```

  - Declaration:

```
Day WorkDay; // creates a Day enum
```

  - Assignment:

```
Day WorkDay = Day.WEDNESDAY;
```

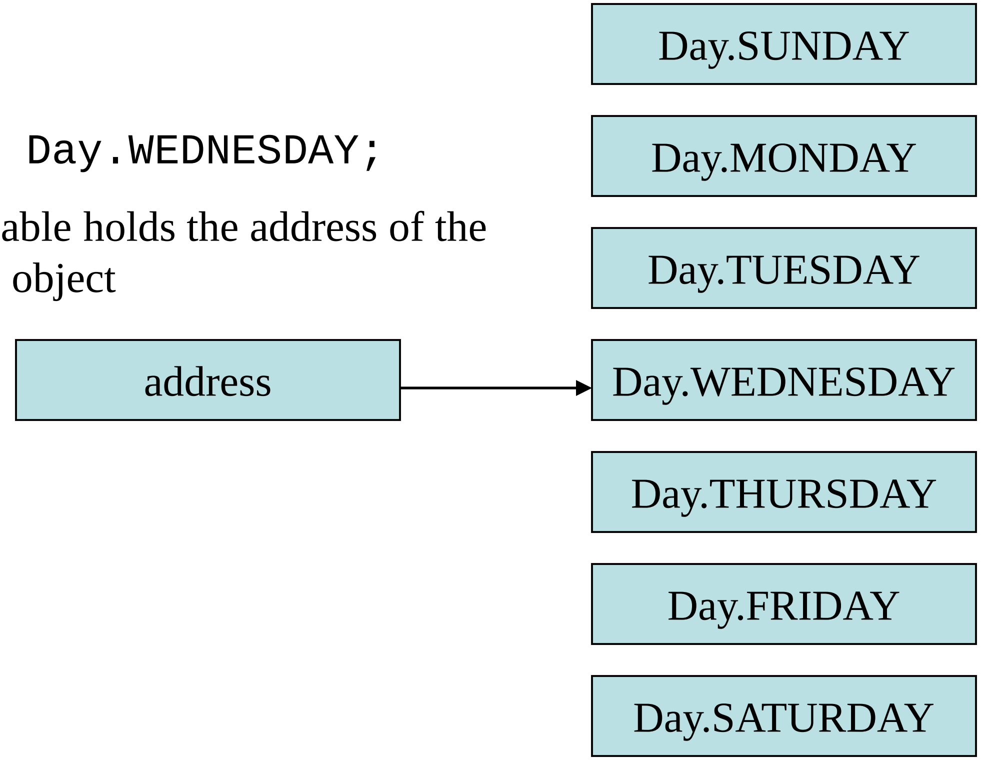
Enumerated Types

- An `enum` is a specialized class

Each are objects of type `Day`, a specialized class

```
Day workDay = Day.WEDNESDAY;
```

The `workDay` variable holds the address of the `Day.WEDNESDAY` object



Enumerated Types - Methods

- `toString` – returns name of calling constant
- `ordinal` – returns the zero-based position of the constant in the enum. For example the ordinal for `Day.THURSDAY` is 4
- `equals` – accepts an object as an argument and returns true if the argument is equal to the calling enum constant
- `compareTo` - accepts an object as an argument and returns a negative integer if the calling constant's ordinal < than the argument's ordinal, a positive integer if the calling constant's ordinal > than the argument's ordinal and zero if the calling constant's ordinal == the argument's ordinal.
- Examples: EnumDemo.java, CarType.java, SportsCar.java, SportsCarDemo.java

Enumerated Types - Switching

- Java allows you to test an enum constant with a `switch` statement.

Example: SportsCarDemo2.java

Garbage Collection

- When objects are no longer needed they should be destroyed.
- This frees up the memory that they consumed.
- Java handles all of the memory operations for you.
- Simply set the reference to *null* and Java will reclaim the memory.

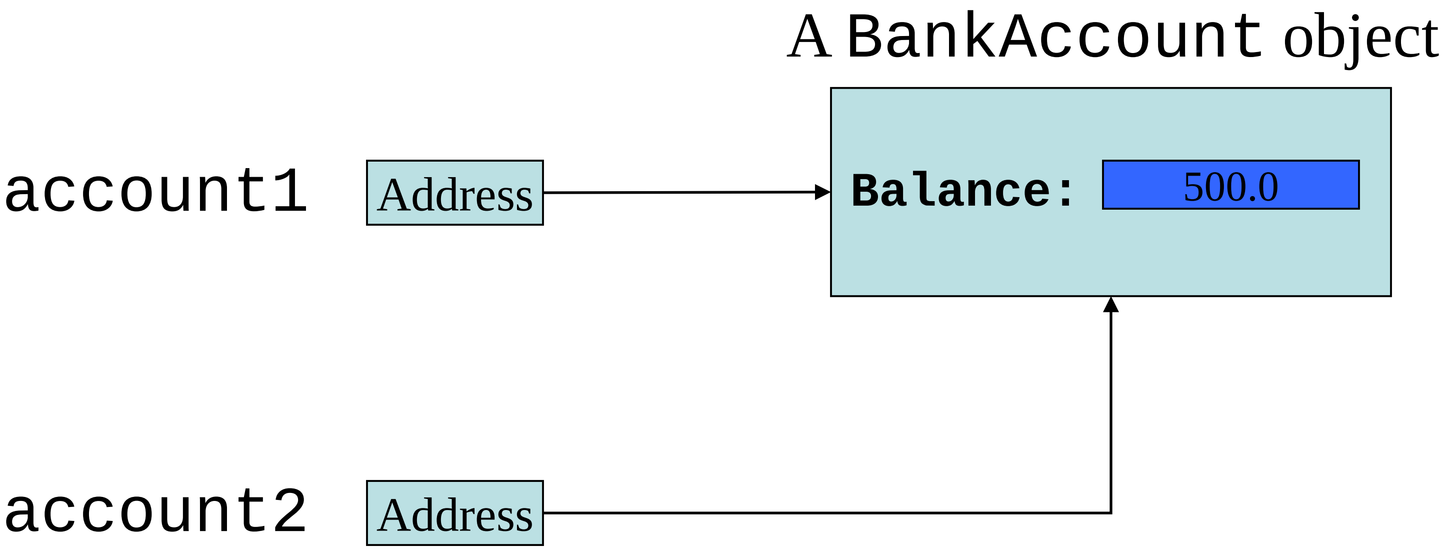
Garbage Collection

- The Java Virtual Machine has a process that runs in the background that reclaims memory from released objects.
- The *garbage collector* will reclaim memory from any object that no longer has a valid reference pointing to it.

```
BankAccount account1 = new BankAccount(500.0);
BankAccount account2 = account1;
```

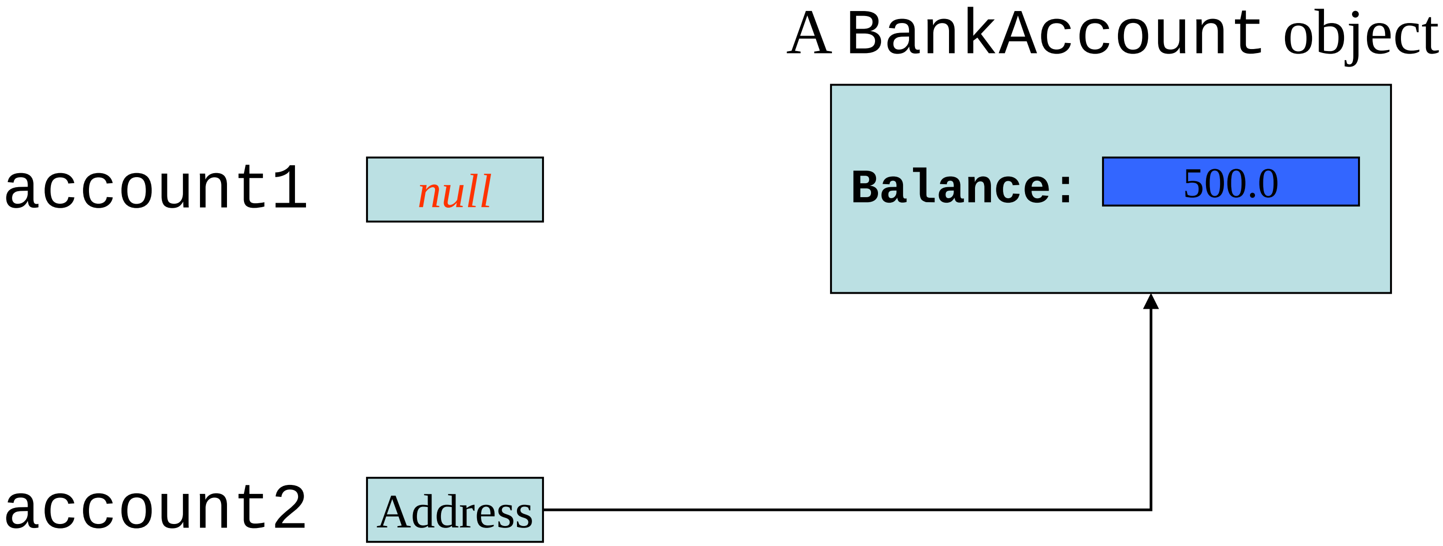
- This sets `account1` and `account2` to point to the same object.

Garbage Collection



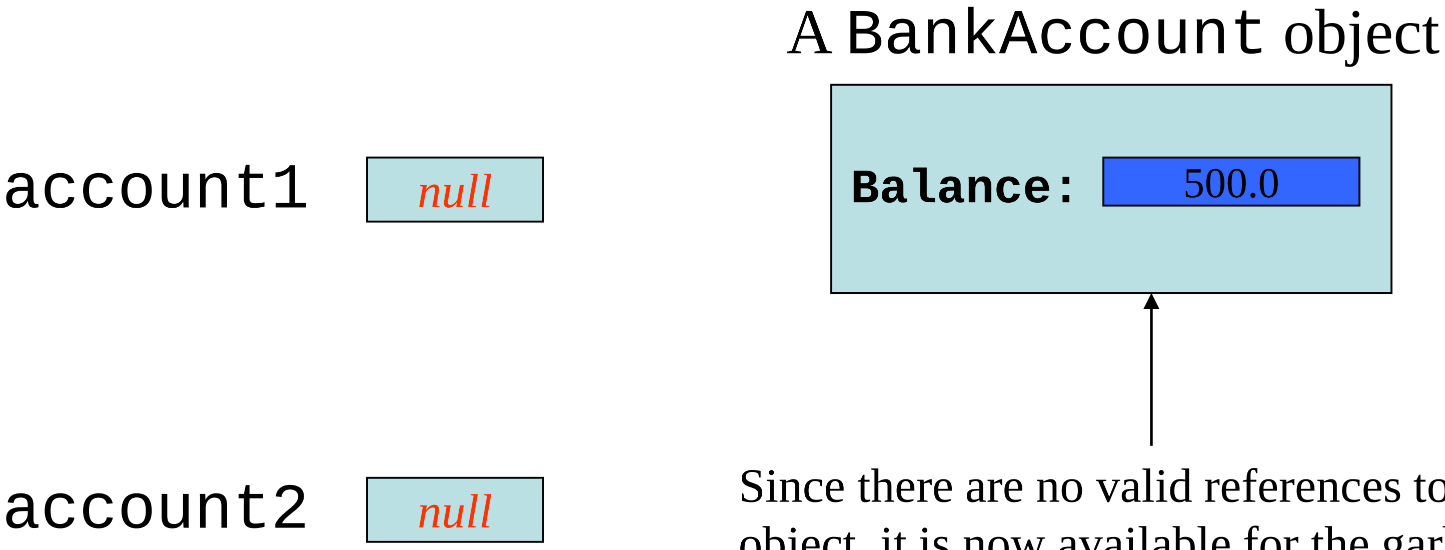
Here, both account1 and account2 point to the same instance of the BankAccount class.

Garbage Collection



However, by running the statement: **account1 = null;**
only account2 will be pointing to the object.

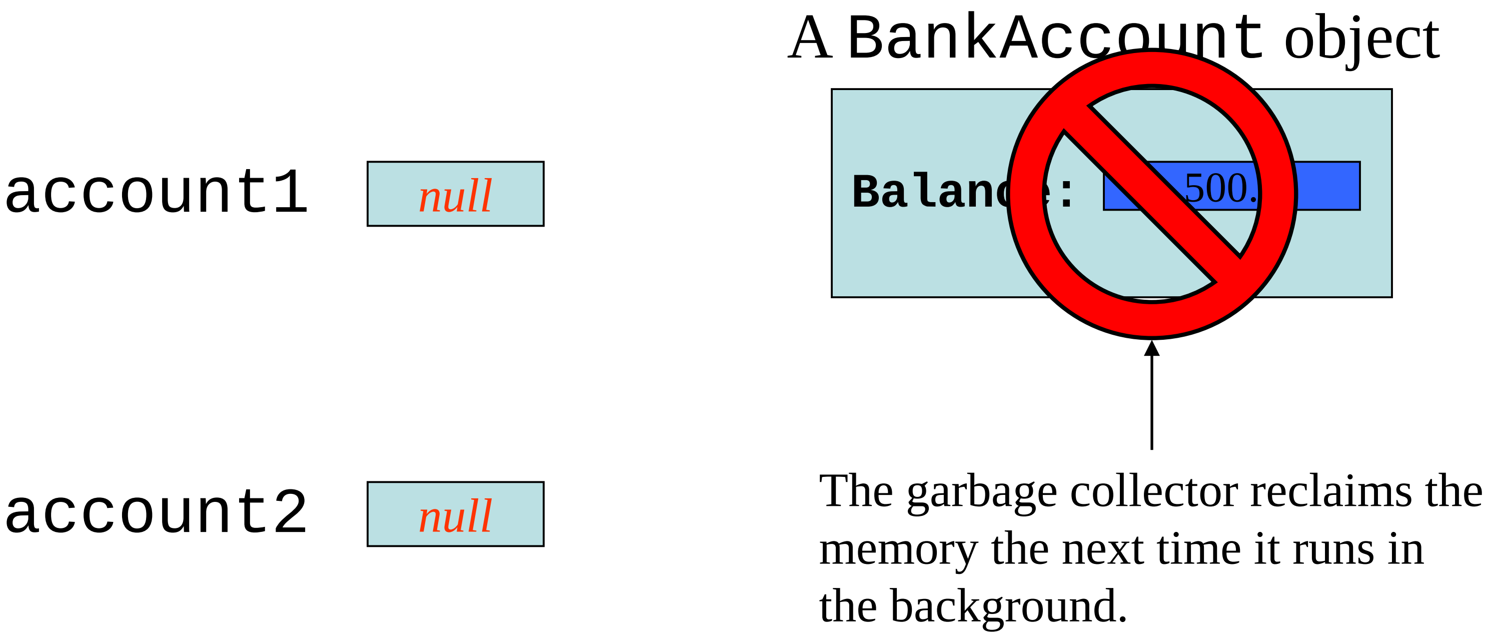
Garbage Collection



Since there are no valid references to this object, it is now available for the garbage collector to reclaim.

If we now run the statement: **`account2 = null;`**
neither `account1` or `account2` will be pointing to the object.

Garbage Collection



A `BankAccount` object

`account1` *null*

`account2` *null*

`Balance:` 500.

The garbage collector reclaims the memory the next time it runs in the background.

The `finalize` Method

- If a method with the signature:

  ```
  public void finalize(){…}
  ```

  is included in a class, it will run just prior to the garbage collector reclaiming its memory.
- The garbage collector is a background thread that runs periodically.
- It cannot be determined when the `finalize` method will actually be run.

Class Collaboration

- Collaboration – two classes interact with each other
- If an object is to collaborate with another object, it must know something about the second object's methods and how to call them
- If we design a class `StockPurchase` that collaborates with the `Stock` class (previously defined), we define it to create and manipulate a `Stock` object

See examples: StockPurchase.java, StockTrader.java

CRC Cards

- Class, Responsibilities and Collaborations (CRC) cards are useful for determining and documenting a class's responsibilities
  - The things a class is responsible for knowing
  - The actions a class is responsible for doing
- CRC Card Layout (Example for class Stock)

Stock	
Know stock to purchase	Stock class
Know number of shares	None
Calculate cost of purchase	Stock class
Etc.	None or class name