# CPSC 233: Introduction to Classes and Objects, Part II

More on Java methods

Relations between classes

- •Association
- •Aggregation

Multiplicity

Issues associated with references

The static keyword

Scope

Classes and state

Debugging code

## More On Java Methods

Method overloading and the signature of a method

Message passing

Implementation hiding

## Method Overloading

- Same method name but the type, number or order of the parameters is different
- Used for methods that implement similar but not identical tasks.
- Good coding style
- Example:

  System.out.println(int)

  System.out.println(double)

  etc.

  For more details on this class see:

  http://java.sun.com/j2se/1.4.2/docs/api/java/io/PrintStream.html

## Method Signatures And Method Overloading

Signature consists of:

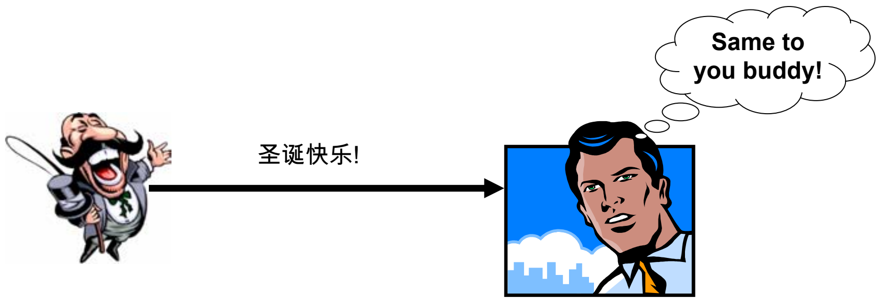
- The name of the method
- The number **and** type of parameters (Reminder: Don't distinguish methods solely by the order of the parameters).

Usage of method signatures:

- To distinguish overloaded methods (same name but the type, number or ordering of the parameters is different).

## Message Passing: General Definition

A communication between a sender and a receiver



## Message Passing: Object-Oriented Definition

A request from the source object that's sent to the destination object to apply one its operations.

An object invoking the methods of another object (which may be the same object or a different object)

e.g.,

```
class Bar
{
    public void aMethod ()
    {
        Foo f = new Foo ();
        f.getNum();
    }
}
```

## Message Passing And Program Design

Procedural approach

- Start with a function or procedure and pass the composite types to this method
- i.e., procedure (record)
- e.g.,

```
 CD =  record
          title        :  array [1..80] of char;
          artist       :  array [1..80] of char;
          price        : real;
          rating       : integer;
          category : char;
        end;
   Collection = array [1..NO] of CD;
        :                              :
procedure displayCollection (tamjCollection : Collection);
```

## Message Passing And Program Design (2)

Object-Oriented approach:

- Start with an object and then determine which method to invoke
- i.e., object.method ()
- e.g.,

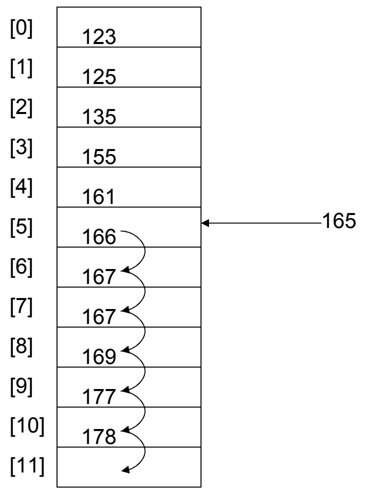
```
class Foo
{
    private int num;
    public void setNum (int n)  { num = n; }
    public int getNum () { return num; }
}
        :              :
f.getNum();
```

## Implementation Hiding

- Allows you to use a program module (e.g., a method) but you don’t care about how the code in the module (implementation) was written.
- For example, a list can be implemented as either an array or as a linked list.

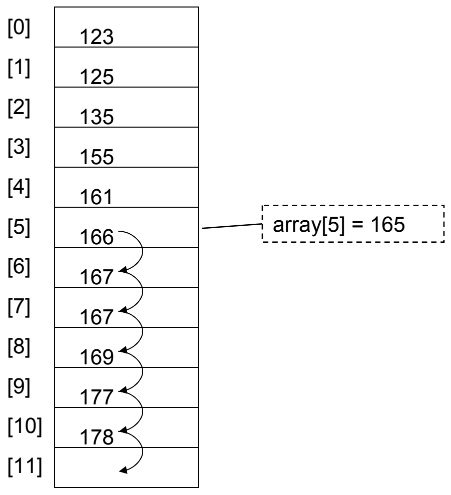
## Implementation Hiding (2)

List implemented as an array (add element)



## Implementation Hiding (2)

List implemented as an array (add element)



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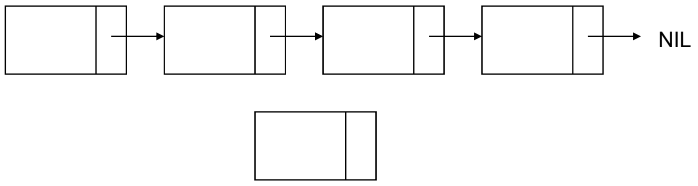
## Implementation Hiding (3)

List implemented as a linked list (add element)



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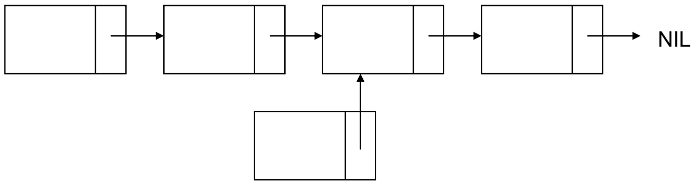
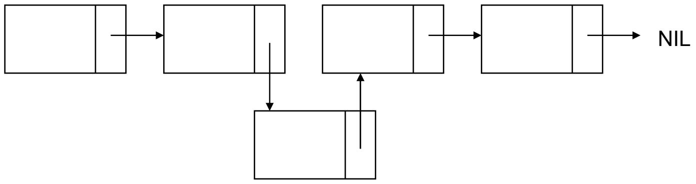
## Implementation Hiding (3)

List implemented as a linked list (add element)



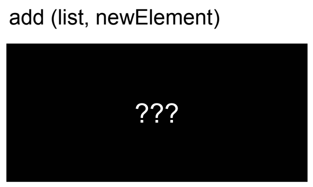
## Implementation Hiding (3)

List implemented as a linked list (add element)



## Implementation Hiding (4)

- Changing the implementation of the list should have a minimal impact on the rest of the program
- The "add" method is a black box.
- We know how to use it without being effected by the details of how it works.



## Relations Between Classes

1. Association (this section)
2. Aggregation (this section)
3. Inheritance (next section)

## Associations Between Classes

Allows for navigation between from one class to another (you can access the public parts of the class):

- An instance of a class is a attribute of another class
- An instance of a class a local variable in another class's method

Also known as a "knows-a" relation

Association relations allows for messages to be sent

## Associations: Bar Is An Attribute Of Foo

```
class Foo
{
      private Bar b;
            :
      public aMethod () { b.cocoa(); }
}

class Bar
{
      public cocoa () { .. }
}
```

## Associations: Bar Is A Local Variable

```
class Foo
{
    public aMethod ()
    {
        Bar b = new Bar ();
        b.cocoa();
    }
}

class Bar
{
    public cocoa () { .. }
}
```

## Directed Associations

Unidirectional

- The association only goes in one direction
- You can only navigate from one class to the other (but not the other way around).
- e.g., You can go from an instance of Foo to Bar but not from Bar to Foo (previous two slides)

## Directed Associations (2)

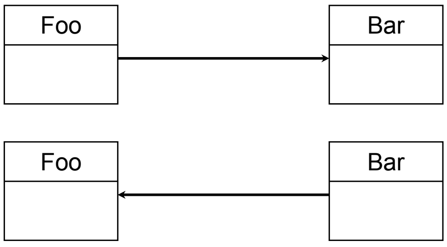
Bidirectional

- The association goes in both directions
- You can navigate from either class to the other
- e.g.,

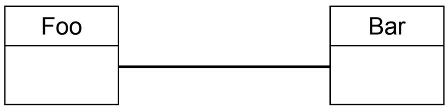
```
class Foo
{
      private Bar b;
            :
}

class Bar
{
      private Foo f;
            :
}
```

## Graphical Representation Of Associations

Unidirectional associations



Bidirectional associations



## Aggregation Relations Between Classes

A stronger form of association between classes

Can occur when a class consists of another class

- An instance of a class an attribute of another class

**and**

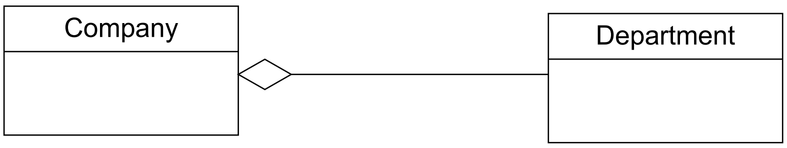
- The first class is a part of the second class

Also known as a "has-a" relation

e.g.,

```
class Company
{
        private Departments d [];
}
```

## Graphical Representations Of Aggregations



## Multiplicity

It indicates the number of instances that participate in a relationship
Also known as cardinality

| Multiplicity | Description |
|---|---|
| 1 | Exactly one instance |
| n | Exactly "n" instances |
| n..m | Any number of instances in the inclusive range from "n" to "m" |
| * | Any number of instances possible |

## Association Vs. Aggregation

•Aggregation is a more specific form of association (one class consists of the other)

•Navigation is not the same as aggregation! (Again: One class is an attribute field of another class **AND** the first class is a part of the second class)

Association

```
class BankAccount
{
    private Person p;
              :
}
```

Aggregation

```
class Person
{
    private Head d;
    private Heart h;
              :
}
```

## Issues Associated With References

Parameter passing

Assignment of references and deep vs. shallow copies

Comparisons of references

## Issues Associated With References

**Parameter passing**

Assignment of references and deep vs. shallow copies

Comparisons of references

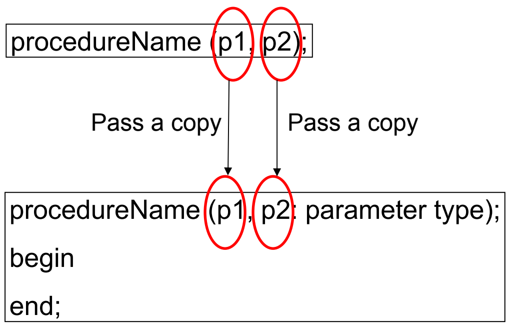
## Parameter Passing Mechanisms

Pass by value

Pass by reference

## Passing Parameters As Value Parameters (*Pass By Value*)

Change made to the parameter(s) in the procedure only changes the copy and not the original parameter(s)

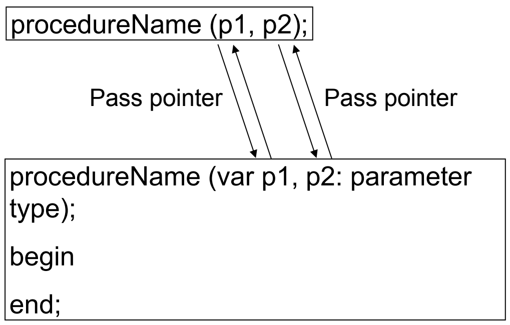


```
procedureName (p1, p2);
```

```
procedureName (p1, p2: parameter type);
begin
end;
```

## Passing Parameters As Variable Parameters (*Pass By Reference*)

Change made to the parameter(s) in the procedure refer to the original parameter(s)



```
procedureName (p1, p2);
```

```
procedureName (var p1, p2: parameter
type);
begin
end;
```

## Passing Simple Types In Java

Built-in (simple) types are **always** passed by value in Java:

- Boolean, byte, char, short, int, long, double, float

Example:

```
int num1, num2;
Foo f = new Foo ();
num1 = 1;
num2 = 2;
System.out.println("num1=" + num1 + "\tnum2=" + num2);
f.swap(num1, num2);
System.out.println("num1=" + num1 + "\tnum2=" + num2);
     :          :          :          :          :          :
```

## Passing Simple Types In Java (2)

```
class Foo
{
   public void swap (int num1, int num2)
   {
      int temp;
      temp = num1;
      num1 = num2;
      num2 = temp;
      System.out.println("num1=" + num1 + "\tnum2=" + num2);
   }
}
```

## Passing References In Java

(Reminder: References are required for variables that are arrays or objects)

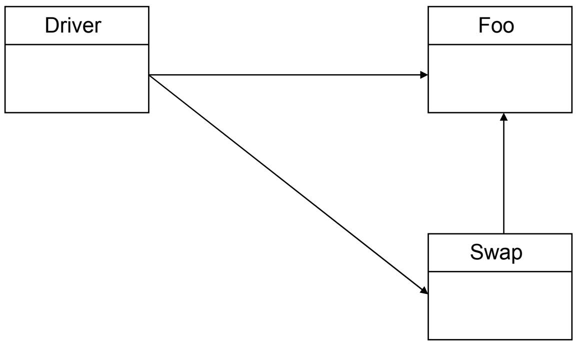
Question:

- If a reference is passed as a parameter to a method do changes made in the method continue on after the method is finished?

Hint: If a reference is passed as a parameter into a method then a copy of the reference is what is being manipulated in the method.

## An Example Of Passing References In Java

Example (The complete example can be found in the directory /home/233/examples/classes_objects2/firstExample



## An Example Of Passing References In Java: The Driver Class

```
class Driver
{
  public static void main (String [] args)
  {
    Foo f1, f2;
    Swap s1;
    f1 = new Foo ();
    f2 = new Foo ();
    s1 = new Swap ();
    f1.setNum(1);
    f2.setNum(2);
```

## An Example Of Passing References In Java: The Driver Class (2)

```
        System.out.println("Before swap:\t f1=" + f1.getNum() +"\tf2=" + f2.getNum());
        s1.noSwap (f1, f2);
        System.out.println("After noSwap\t f1=" + f1.getNum() +"\tf2=" + f2.getNum());
        s1.realSwap (f1, f2);
        System.out.println("After realSwap\t f1=" + f1.getNum() +"\tf2=" + f2.getNum());
    }
}
```

## An Example Of Passing References In Java: Class Foo

```
class Foo
{
    private int num;
    public void setNum (int n)
    {
        num = n;
    }
    public int getNum ()
    {
        return num;
    }
}
```

## An Example Of Passing References In Java: Class Swap

```
class Swap
{
   public void noSwap (Foo f1, Foo f2)
   {
      Foo temp;
      temp = f1;
      f1 = f2;
      f2 = temp;
      System.out.println("In noSwap\t f1=" + f1.getNum () + "\tf2=" +
           f2.getNum());
   }
```

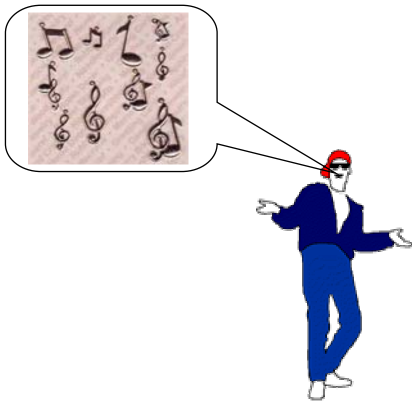
## An Example Of Passing References In Java: Class Swap (2)

```
    public void realSwap (Foo f1, Foo f2)
   {
      Foo temp = new Foo ();
      temp.setNum(f1.getNum());
      f1.setNum(f2.getNum());
      f2.setNum(temp.getNum());
      System.out.println("In realSwap\t f1=" + f1.getNum () + "\tf2=" + f2.getNum());
   }
}  // End of class Swap
```

## Passing By Reference For Simple Types

It cannot be done directly in Java

You must use a wrapper!



## Wrapper Class

A class definition built around a simple type

e.g.,

```
class Wrapper
{
    private int num;
    public int getNum () { return num; }
    public void setNum (int n) { num = n; }
}
```

## Issues Associated With References

Parameter passing

**Assignment of references and deep vs. shallow copies**

Comparisons of references

## Assignment Operator: Works On The Reference

```
Foo f1, f2;
f1 = new Foo ();
f2 = new Foo ();
f1.setNum(1);
f2.setNum(2);
System.out.println("f1=" + f1.getNum() + "\tf2=" + f2.getNum());
f1 = f2;
f1.setNum(10);
f2.setNum(20);
System.out.println("f1=" + f1.getNum() + "\tf2=" + f2.getNum());
```

## Shallow Copy Vs. Deep Copies

Shallow copy

- Copy the address in one reference into another reference
- Both references point to the same dynamically allocated memory location
- e.g.,

```
Foo f1, f2;
f1 = new Foo ();
f2 = new Foo ();
f1 = f2;
```

## Shallow Vs. Deep Copies (2)

Deep copy

- Copy the contents of the memory location pointed to by the reference
- The references still point to separate locations in memory.
- e.g.,

```
f1 = new Foo ();
f2 = new Foo ();
f1.setNum(1);
f2.setNum(f1.getNum());
System.out.println("f1=" + f1.getNum() + "\tf2=" + f2.getNum());
f1.setNum(10);
f2.setNum(20);
System.out.println("f1=" + f1.getNum() + "\tf2=" + f2.getNum());
```

## Issues Associated With References

Parameter passing

Assignment of references and deep vs. shallow copies

**Comparisons of references**

## Comparison Of The References

```
f1 = new Foo2 ();
f2 = new Foo2 ();
f1.setNum(1);
f2.setNum(f1.getNum());
if (f1 == f2)
  System.out.println("References point to same location");
else
  System.out.println("References point to different locations");
```

## Comparison Of The Data

```
f1 = new Foo2 ();
f2 = new Foo2 ();
f1.setNum(1);
f2.setNum(f1.getNum());
if (f1.getNum() == f2.getNum())
  System.out.println("Same data");
else
  System.out.println("Different data");
```

## Self Reference: This Reference

From every (non-static) method of an object there exists a reference to the object (called the “this” reference)

e.g.,

```
Foo f1 = new Foo ();
Foo f2 = new Foo ();
f1.setNum(10);

class Foo
{
      private int num;
      public void setNum (int num)
```

## Self Reference: This Reference

From most every method of an object there exists a pointer to the object ("this")

e.g.,

```
Foo f1 = new Foo ();
Foo f2 = new Foo ();
f1.setNum(10);

class Foo
{
    private int num;
    public void setNum (int num)
    {
        this.num = num;
    }
        :           :
}
```

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## Uses Of "This": Checking For Equality

Example (The complete example can be found in the directory /home/233/examples/classes_objects2/secondExample

```
class Driver
{
  public static void main (String [] args)
  {
    Foo f1 = new Foo(1);
    Foo f2 = new Foo(2);
    if (f1.equals(f2))
      System.out.println("Data of f1 and f2 the same.");
    else
      System.out.println("Data of f1 and f2 are not the same.");
  }
}
```

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## Uses Of “This”: Checking For Equality (2)

```
class Foo
{
   private int num;

   public Foo ()
   {
      num = 0;
   }

   public Foo (int no)
   {
      num = no;
   }

   public void setNum (int n)
   {
      num = n;
   }
```

## Uses Of “This”: Checking For Equality (3)

```
   public int getNum ()
   {
      return num;
   }

   public boolean equals (Foo compareTo)
   {
      if (num == compareTo.num)
        return true;
      else
        return false;
   }
}
```

## Uses Of “This”: Checking For Equality (3)

```
    public int getNum ()
    {
       return num;
    }

    public boolean equals (Foo compareTo)
    {
        if (this.num == compareTo.num)
          return true;
        else
          return false;
    }
}
```

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## Explicit Vs. Implicit Parameters

Explicit parameters

- Are the parameters enclosed within the brackets of a method call.
- e.g.,

```
Foo f = new Foo ();
int no = 10;
f.setNum(no);
```

Implicit parameters

- Do not need to be explicitly passed into a method in order to be used
- The “this” pointer is an explicit parameter

James Tam

## The String Class Revisited

A Java class but the attribute fields can be displayed directly (via print/println)

A String is created like a simple type (when double quotes are encountered).

Any of the simple types will be converted to a string when passed to the print/println method.

String concatenation:

- Plus sign: e.g., System.out.println(“Str1” + “Str2”);
- Method: e.g., public String concat (String str)

For more detailed information regarding the String class go to the url:

**http://java.sun.com/j2se/1.4/docs/api/java/lang/String.html**

## Incorrect Test For String Equality

```
import tio.*;
class Driver
{
   public static void main (String [] args)
   {
      String response;
      int num;
      do
      {
         System.out.print("Enter a number: ");
         num = Console.in.readInt();
         Console.in.readChar();
         System.out.print("Enter 'q' to quit: ");
         response = Console.in.readWord();
      } while (response != "q");
   }
}
```

## Correct Test For String Equality

```
import tio.*;
class Driver5
{
   public static void main (String [] args)
   {
      String response;
      int num;
      do
      {
         System.out.print("Enter a number: ");
         num = Console.in.readInt();
         Console.in.readChar();
         System.out.print("Enter 'q' to quit: ");
         response = Console.in.readWord();
      } while (response.equals(“q") == false);
   }
}
```

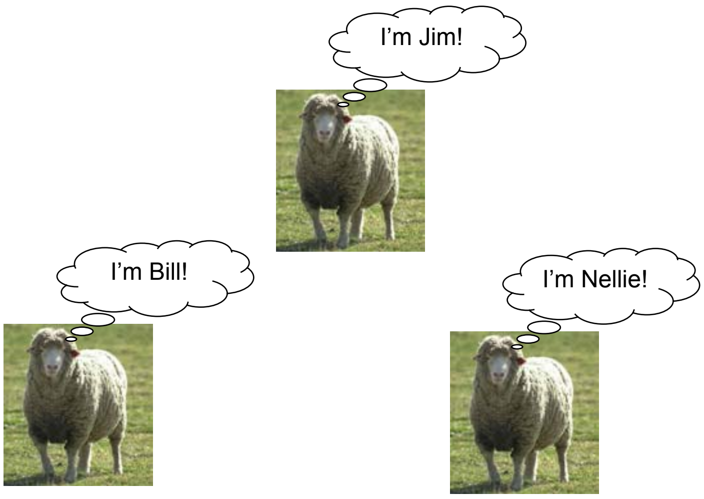
## A Previous  Example Revisited: Class Sheep

```
class Sheep
{
  private String name;

   public Sheep ()
   {
      System.out.println("Creating \"No name\" sheep");
      name = "No name";
   }
   public Sheep (String n)
   {
      System.out.println("Creating the sheep called " + n);
      name = n;
   }
   public String getName () { return name;}

   public void changeName (String n) { name = n; }
}
```

## We Now Have Several Sheep



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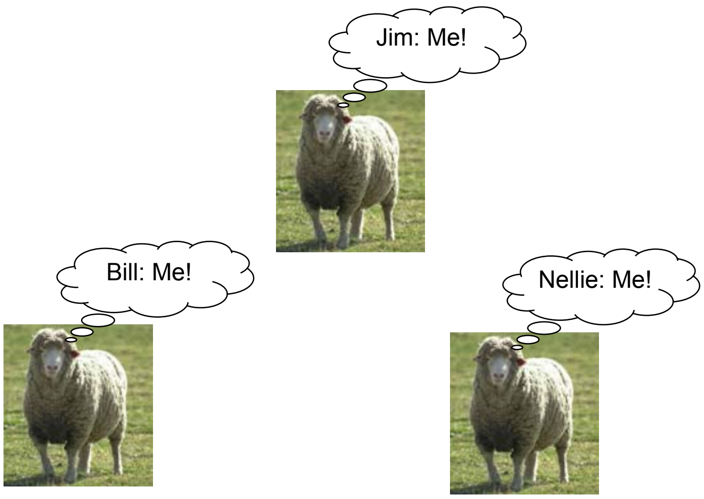
## Question: Who Tracks The Size Of The Herd?



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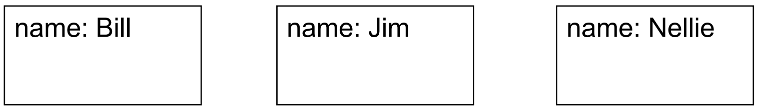
## Answer: None Of The Above!

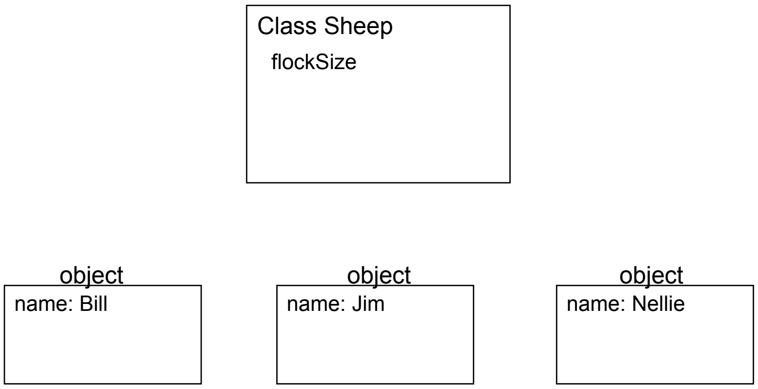
- Information about all instances of a class should not be tracked by an individual object
- So far we have used instance fields
- Each *instance* of an object contains *it's own set of instance fields* which can contain information unique to the instance

```
class Sheep
{
  private String name;
      :        :       :
}
```



## The Need For Static (Class Fields)

Static fields: One instance of the field exists for the class (not for the instances of the class)



## Static (Class) Methods

- Are associated with the class as a whole and not individual instances of the class
- Often used to act on the class fields

## Static Data And Methods: The Driver Class

Example (The complete example can be found in the directory /home/233/examples/classes_objects2/thirdExample

```
class Driver
{
  public static void main (String [] args)
  {
    System.out.println();
    System.out.println("You start out with " + Sheep.getFlockSize() + " sheep");
    System.out.println("Creating flock...");
    Sheep nellie = new Sheep ("Nellie");
    Sheep bill = new Sheep("Bill");
    Sheep jim = new Sheep();
```

## Static Data And Methods: The Driver Class (2)

```
        System.out.print("You now have " + Sheep.getFlockSize() + " sheep:");
        jim.changeName("Jim");
        System.out.print("\t"+ nellie.getName());
        System.out.print(", "+ bill.getName());
        System.out.println(", "+ jim.getName());
        System.out.println();
    }
}  // End of Driver class
```

## Static Data And Methods: The Sheep Class

```
class Sheep
{
    private static int flockSize;
    private String name;

    public Sheep ()
    {
        flockSize++;
        System.out.println("Creating \"No name\" sheep");
        name = "No name";
    }

    public Sheep (String n)
    {
        flockSize++;
        System.out.println("Creating the sheep called " + n);
        name = n;
    }
```

## Static Data And Methods: The Sheep Class (2)

```
    public static int getFlockSize () { return flockSize; }

    public String getName () {  return name; }

    public void changeName (String n)  { name = n; }

    public void finalize ()
    {
        System.out.print("Automatic garbage collector about to be called for ");
        System.out.println(this.name);
        flockSize--;
    }
}  // End of definition for class Sheep
```

## Static Vs. Final

Static: Means one instance of the field for the class (not individual instances for each instance of the class)

Final: Means that the field cannot change (it is a constant)

```
class Sheep
{
      public static final int num1= 1;
      private static int num2;              /*  Rare */
      public final int num3 = 1;            /* Why bother? */
      private int num4;
            :         :
}
```

## Rules Of Thumb: Instance Vs. Class Fields

If a attribute field can differ between instances of a class:

- The field probably should be an instance field

If the attribute field relates to the class or to all instances of the class

- The field probably should be a static field of the class

## Rule Of Thumb: Instance Vs. Class Methods

- If a method should be invoked regardless of the number of instances that exist then it probably should be a static method
- Otherwise the method should likely be an instance method.

## An Example Class With A Static Implementation

```
class Math
{
   // Public constants
   public static final double E = 2.71…
   public static final double PI = 3.14…

   // Public methods
   public static int abs (int a);
   public static long abs (long a);
            :               :
}
```

For more information about this class go to:
http://java.sun.com/j2se/1.4.2/docs/api/java/lang/Math.html

James Tam

## Should A Class Be Entirely Static?

- Generally should be avoided if possible
- Usually purely static classes (cannot be instantiated) have only methods and no data (maybe some constants)

James Tam

## A Common Error With Static Methods

Recall: The “this” reference is an implicit parameter that is automatically passed into a method.

e.g.,

```
Foo f = new Foo ();
f.setNum(10);
```

Explicit parameter

Implicit parameter
“this”

## A Common Error With Static Methods

Static methods have no “this” reference as an implicit parameter.

```
class Driver
{
   private int num;
   public static void main (String [] args)
   {
      num = 10;
   }
}
```

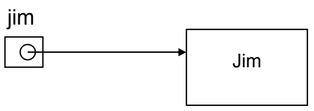
Compilation error:

```
Driver3.java:6: non-static variable num cannot be referenced from a static context
        num = 10;
        ^
error
```

## The Finalize Method

Example sequence:

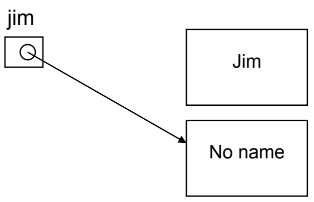
```
Sheep jim = new Sheep ("Jim");
```



## The Finalize Method

Example sequence:

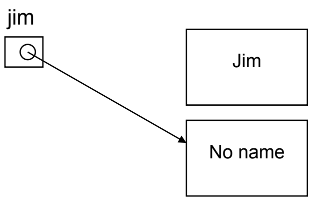
```
Sheep jim = new Sheep ("Jim");

            :

      jim = new Sheep ();
```



## The Finalize Method

Example sequence:

```
Sheep jim = new Sheep ("Jim");

:

jim = new Sheep ();
```

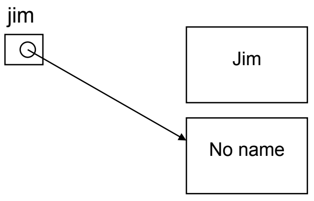


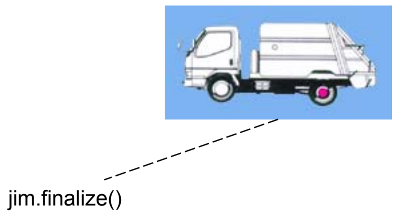
When???

## The Finalize Method

Example sequence:

```
Sheep jim = new Sheep ("Jim");

:

jim = new Sheep ();
```

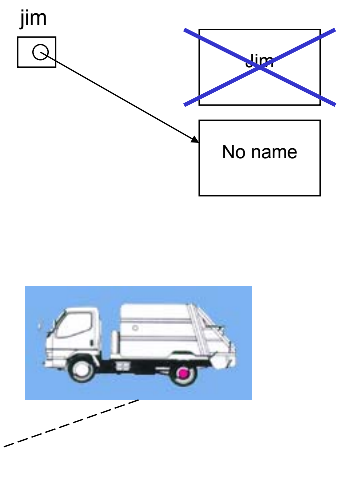




## The Finalize Method

Example sequence:

```
Sheep jim = new Sheep ("Jim");
                :
      jim = new Sheep ();
```



## Synopsis Of The Finalize Method

- The Java interpreter tracks what memory has been dynamically allocated.
- It also tracks when memory is no longer referenced.
- When system isn't busy, the Automatic Garbage Collector is invoked.
- If an object has a finalizer method then it is invoked:
  - The finalizer is a method written by the programmer to free up non-memory resources e.g., closing and deleting temporary files created by the program, network connections.
  - This method takes no arguments and returns no values.
  - Dynamic memory is **NOT** freed up by this method.
- Then the dynamic memory is freed up by the Automatic Garbage Collector.

## Scope Of Local Variables

Enter into scope
- Just after declaration

Exit out of scope
- When the proper enclosing brace is encountered

```
class Foo
{
    public void aMethod ()
    {
        int num1 = 2;
        if (num1 % 2 == 0)
        {
            int num2;
            num2 = 2;
        }
    }
```

## Scope Of Local Variables

Enter into scope
- Just after declaration

Exit out of scope
- When the proper enclosing brace is encountered

```
class Foo
{
    public void aMethod ()
    {
        int num1 = 2;           ⎫
        if (num1 % 2 == 0)      ⎪
        {                       ⎪
            int num2;           ⎬  Scope of num1
            num2 = 2;           ⎪
        }                       ⎭
    }
```

## Scope Of Local Variables

Enter into scope
- Just after declaration

Exit out of scope
- When the proper enclosing brace is encountered

```
class Foo
{
        public void aMethod ()
        {
            int num1 = 2;
            if (num1 % 2 == 0)
            {
                 int num2;
                 num2 = 2;
            }
        }
```

Scope of num2

James Tam

## Overlapping Scope

- Variables with the same name cannot have overlapping scope

```
class Foo
{
    public void aMethod;
    {
          int num1 = 2;
          int num1 = 1;
     }
}
```

James Tam

## Overlapping Scope

- Variables with more local scope will shadow (hide) variables with a more generalized scope

```
class Foo
{
    public void aMethod;
    {
         int num1 = 2;
         if (num1 % 2 == 0)
        {
            int num1;
            num1 = 2;
        }
    }
}
```

## Scope Of Instance/Class Constants And Variables

Constants stay in scope for the entire class definition (opening-closing brace)

Instance variables and instance methods

- Can access the attributes by the name of the attribute alone (because of the implicit parameter “this”)

Instance variables and static methods

- Can’t access the attributes by the name of the attribute alone (because there is no implicit parameter “this”)

## Scoping Example: The Driver Class

Example (The complete example can be found in the directory /home/233/examples/classes_objects2/fourthExample

```
class Driver
{
   public static void main (String [] args)
   {
      Foo f1, f2;
      f1 = new Foo ();
      f2 = new Foo ();
      Foo.classMethod();
      System.out.println();
      f1.instanceMethod();
      System.out.println();
      f2.instanceMethod();
      System.out.println();
   }
}
```

## Scoping Example: Class Foo

```
class Foo
{
   public static void classMethod ()
   {
      // System.out.println("Variable=" + variable1);
      System.out.println("\"classMethod\"");
      System.out.println("Constant=" + constant1);
   }

   public void instanceMethod ()
   {
      System.out.println("\"instanceMethod\"");
      System.out.println("Variable=" + variable1);
      System.out.println("Constant=" + constant1);
   }
   private int variable1;
   public final static int constant1 = 888;
}
```

## Classes And State

The state of an object is determined by the values of it's attributes.

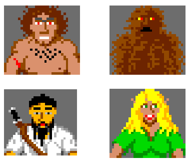
The states of objects can be modeled by State diagrams

Not all attributes are modeled

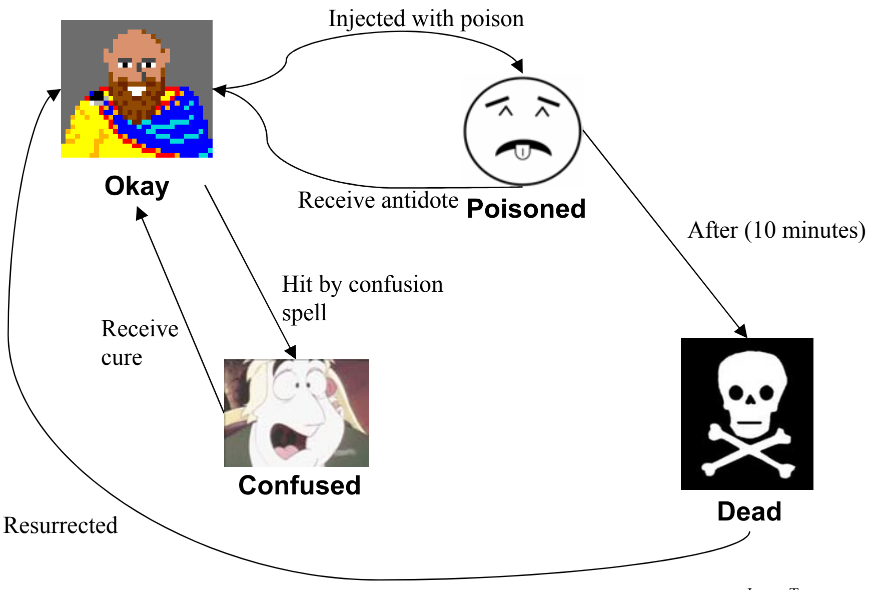
- The attribute can only take on a limited range of values e.g., boolean
- The attribute has restrictions that determine which values that it may take on. e.g., programmer defined ranges for a long

## Example Class: Adventurer

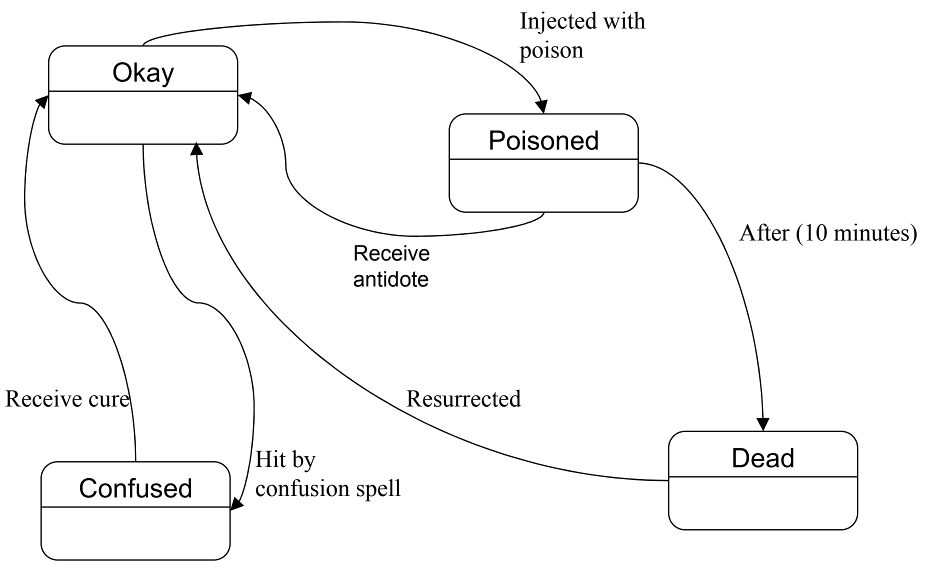
```
Class Adventurer
{
        private boolean okay;
        private boolean poisoned;
        private boolean confused;
        private boolean dead;
                :
}
```



## Class Adventurer: The Set Of States



## Class Adventurer: State Diagram

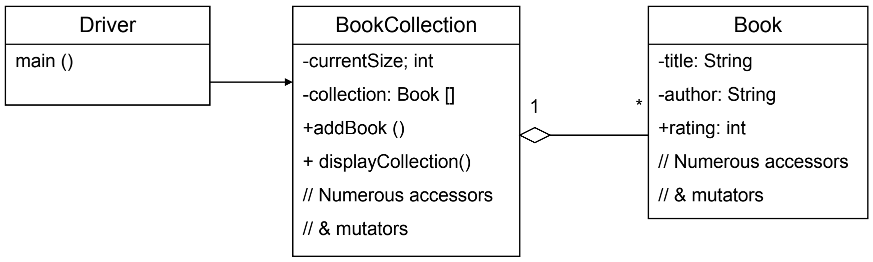


## Determining The State Of Objects

Determining the value of the attributes of a object (state) can be a useful debugging tool.

## An Example Of Determining Object's State

Example (The complete example can be found in the directory /home/233/examples/classes_objects2/fifthExample



## An Example Of Determining Object's State: The Driver Class

```
class Driver
{
   public static void main (String [] args)
   {
      BookCollection tamjCollection = new BookCollection ();
      tamjCollection.displayCollection();
   }
}
```

## An Example Of Determining Object's State: The BookCollection Class

```
class BookCollection
{
   public final static int MAX_SIZE = 4;
   private int currentSize;
   private Book [] collection;

   public BookCollection ()
   {
      int i;
      currentSize = 0;
      collection = new Book [MAX_SIZE];
      for (i = 0; i < MAX_SIZE; i++)
      {
         addBook();
      }
   }
```

## An Example Of Determining Object’s State: The BookCollection Class (2)

```
public int getCurrentSize ()
{
   return currentSize;
}

public void setCurrentSize (int s)
{
   currentSize = s;
}

public void addBook ()
{
   Book b = new Book ();
   b.setAllFields();
   collection[currentSize] = b;
   currentSize++;
}
```

## An Example Of Determining Object’s State: The BookCollection Class (3)

```
 public void displayCollection ()
 {
    int i, no;
    System.out.println("\nDISPLAYING COLLECTION");
    no = 1;
    for (i = 0; i < MAX_SIZE; i++)
    {
       System.out.println("\tBook #"+no);
       System.out.println("\tTitle: " + collection[i].getTitle());
       System.out.println("\tAuthor: " + collection[i].getAuthor());
       System.out.println("\tRating: " + collection[i].getRating());
       System.out.println();
       no++;
    }
 }
}  // End of the BookCollection class
```

## An Example Of Determining Object's State: The Book Class

```
class Book
{
    private String title;
    private String author;
    private int rating;
    public Book ()
    {
        title = "No title given";
        author = "No author listed";
        rating = -1;
    }
    public Book (String t, String a, int r)
    {
        title = t;
        author = a;
        rating = r;
    }
```

James Tam

## An Example Of Determining Object's State: The Book Class (2)

```
    public String getTitle ()
    {
        return title;
    }

    public void setTitle (String t)
    {
        title = t;
    }

    public String getAuthor ()
    {
        return author;
    }

    public void setAuthor (String a)
    {
        author = a;
    }
```

James Tam

## An Example Of Determining Object’s State: The Book Class (3)

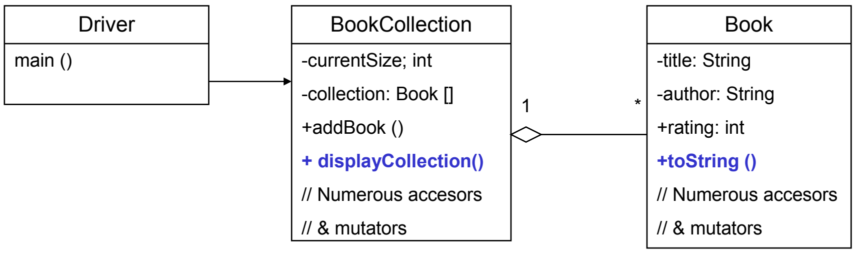
```
 public int getRating ()
{
   return rating;
}

public void setRating (int r)
{
   if ((rating >= 1) && (rating <= 5))
       rating = r;
   else
       System.out.println("The rating must be a value between 1 and 5
            (inclusive");
}
```

## An Example Of Determining Object’s State: The Book Class (4)

```
  public void setAllFields ()
  {
     System.out.print("Enter the title of the book: ");
     title = Console.in.readLine();
     System.out.print("Enter the author of the book: ");
     author = Console.in.readLine();
     do
     {
        System.out.print("How would you rate the book (1 = worst, 5 = best): ");
        rating = Console.in.readInt();
        if ((rating < 1) || (rating > 5))
            System.out.println("Rating must be a value between 1 and 5");
     } while ((rating < 1) || (rating > 5));
     Console.in.readChar();
     System.out.println();
  }
}  // End of class Book
```

## An Revised Example Of Determining Object's State

Example (The complete example can be found in the directory /home/233/examples/classes_objects2/sixthExample



## A Revised Example Of Determining Object's State: The Driver Class

```
class Driver
{
   public static void main (String [] args)
   {
      BookCollection tamjCollection = new BookCollection ();
      tamjCollection.displayCollection();
   }
}
```

## A Revised Example Of Determining Object's State: The BookCollection Class

```
class BookCollection
{
   public final static int MAX_SIZE = 4;
   private int currentSize;
   private Book [] collection;

   public BookCollection ()
   {
      int i;
      currentSize = 0;
      collection = new Book [MAX_SIZE];
      for (i = 0; i < MAX_SIZE; i++)
      {
         addBook();
      }
   }
```

## A Revised Example Of Determining Object's State: The BookCollection Class (2)

```
   public int getCurrentSize ()
   {
      return currentSize;
   }

   public void setCurrentSize (int s)
   {
      currentSize = s;
   }

   public void addBook ()
   {
      Book b = new Book ();
      b.setAllFields();
      collection[currentSize] = b;
      currentSize++;
   }
```

## A Revised Example Of Determining Object's State: The BookCollection Class (3)

```
  public void displayCollection ()
  {
     int i, no;
     System.out.println("\nDISPLAYING COLLECTION");
     no = 1;
     for (i = 0; i < MAX_SIZE; i++)
     {
        System.out.println("\tBook #"+no);
        System.out.println(collection[i]);
        System.out.println();
        no++;
     }
  }
}   // End of class BookCollection
```

## A Revised Example Of Determining Object's State: The Book Class

```
class Book
{
   private String title;
   private String author;
   private int rating;

   public Book ()
   {
      title = "No title given";
      author = "No author listed";
      rating = -1;
   }

   public Book (String t, String a, int r)
   {
      title = t;
      author = a;
      rating = r;
   }
```

## A Revised Example Of Determining Object's State: The Book Class (2)

```
 public String getTitle ()
{
   return title;
}

public void setTitle (String t)
{
   title = t;
}

public String getAuthor ()
{
   return author;
}

public String getTitle ()
{
   return title;
}
```

## A Revised Example Of Determining Object's State: The Book Class (3)

```
public void setTitle (String t)
{
   title = t;
}

public String getAuthor ()
{
   return author;
}

 public void setRating (int r)
{
   if ((rating >= 1) && (rating <= 5))
      rating = r;
   else
      System.out.println("The rating must be a value between 1 and 5
         (inclusive");
}
```

## A Revised Example Of Determining Object's State: The Book Class (4)

```
public void setAllFields ()
  {
      System.out.print("Enter the title of the book: ");
      title = Console.in.readLine();
      System.out.print("Enter the author of the book: ");
      author = Console.in.readLine();
      do
      {
         System.out.print("How would you rate the book (1 = worst, 5 = best): ");
         rating = Console.in.readInt();
         if ((rating < 1) || (rating > 5))
            System.out.println("Rating must be a value between 1 and 5");
      } while ((rating < 1) || (rating > 5));
      Console.in.readChar();
      System.out.println();
  }
```

## A Revised Example Of Determining Object's State: The Book Class (5)

```
   public String toString ()
  {
     String temp = new String ();
     temp = temp + "\tTitle: " + title + "\n";
     temp = temp + "\tAuthor: " + author + "\n";
     temp = temp + "\tRating: " + rating + "\n";
     return temp;
  }
}   // End of class Book
```

## You Should Now Know

- New terminology and concepts relevant to methods: message passing, method signatures, overloading of methods
- What is implementation hiding and what is the benefit of employing it
- Two types of relationships that can exist between classes: associations and aggregation
- Some specific issues and problems associated with Java references
  - The parameter passing mechanism that is employed for different types in Java
  - How does the assignment and comparison of references work in Java
  - What is the "this" reference: how does it work and when is used

## You Should Now Know (2)

- What is the difference between static and instance methods, and static and instance attributes and when to should each one be employed
- More advanced concepts in the Java garbage collection process: the finalize method and how it fits into the garbage collection for references
- What is the scope of the different attributes and methods of a class
- Classes and states:
  - What is meant by the state of an instance of a class
  - Debugging programs by examining the state of instances