Review for the Final Exam

December 7, 2007

ComS 207: Programming I (in Java)
Iowa State University, FALL 2007
Instructor: Alexander Stoytchev

Final Exam

- **Time:**
  - **Thursday Dec 13 @ 4:30-6:30 p.m.**
- **Location:**
  - **Curtiss Hall, room 127 (classroom).**

Final Format

• True/False	(10 x 1p each = 10p)
• Short answer	(5 x 3p each = 15p)
• Code Snippets	(4 x 5p each = 20p)
• What is the output	(2 x 5p each = 10p)
• Program 1	(20p)
• Program 2	(25p)
• Program 3	(30p)
• TOTAL	(130p)

Final Format

- **You don’t need to get all 130 points to get an A**
- **100 is a 100**
- **You must get at least 65 points in order to pass this exam**

Ways to get an ‘A’ on the Final

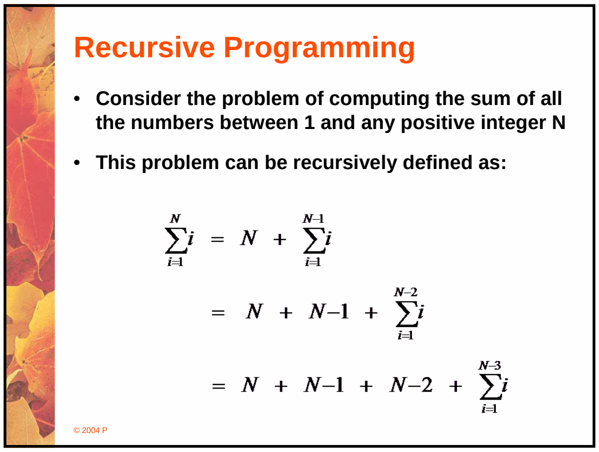
- **Option 1:**

▪ 3 program	(75p)
▪ True/False	(10p)
▪ Short Answers	(15p)
▪ TOTAL:	(100p)

- **Option 2:**

▪ 2 programs	(45p)
▪ True/False	(10p)
▪ Short Answers	(15p)
▪ Code Snippets	(20p)
▪ What is the output	(10p)
▪ TOTAL:	(100p)

A Crash Course in Java



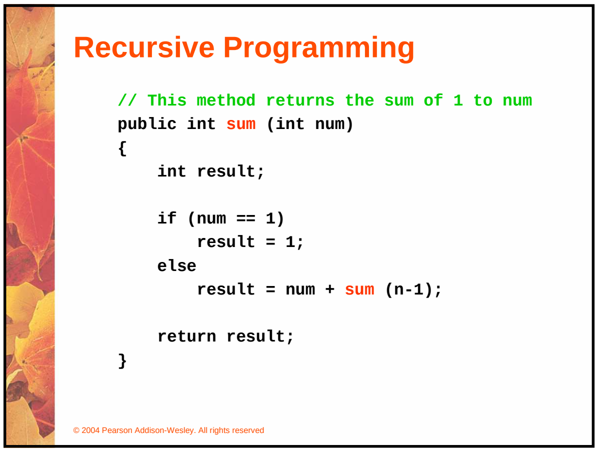
Recursive Programming

- Consider the problem of computing the sum of all the numbers between 1 and any positive integer N
- This problem can be recursively defined as:

$$\sum_{i=1}^{N} i = N + \sum_{i=1}^{N-1} i$$

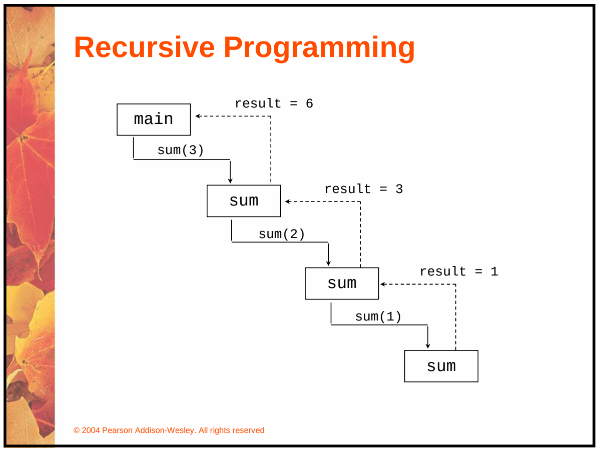
$$= N + N-1 + \sum_{i=1}^{N-2} i$$

$$= N + N-1 + N-2 + \sum_{i=1}^{N-3} i$$

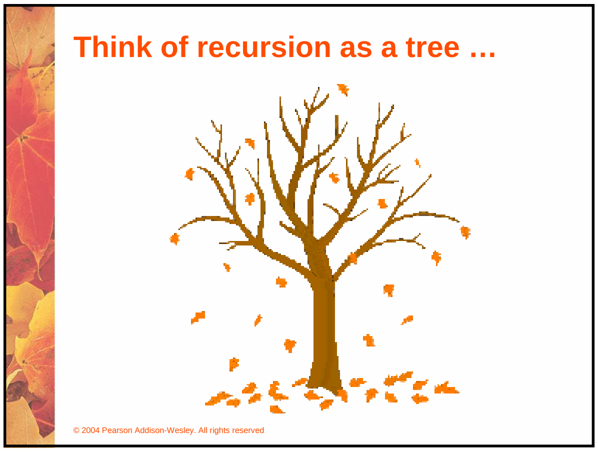


Recursive Programming

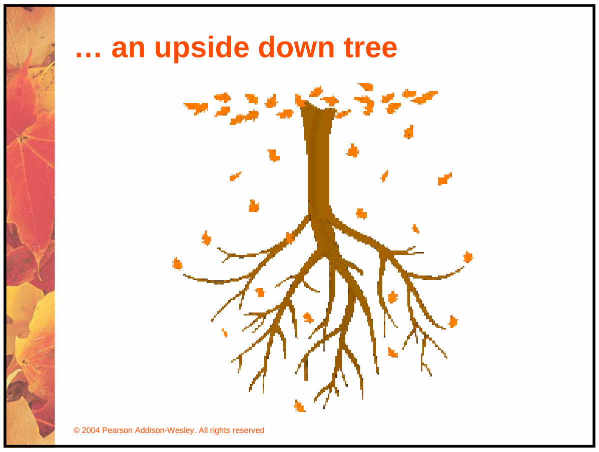
```
// This method returns the sum of 1 to num
public int sum (int num)
{
    int result;

    if (num == 1)
        result = 1;
    else
        result = num + sum (n-1);

    return result;
}
```



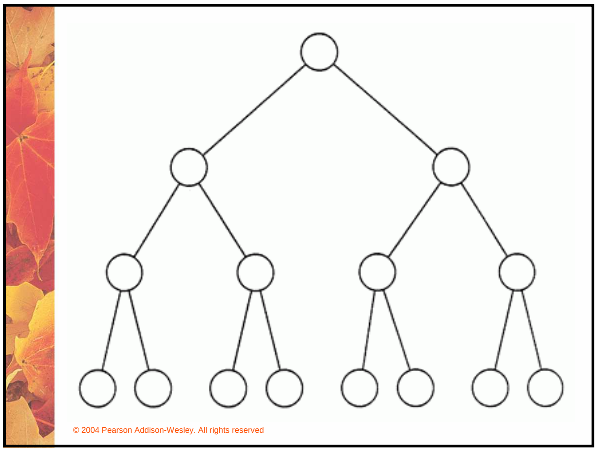
Recursive Programming

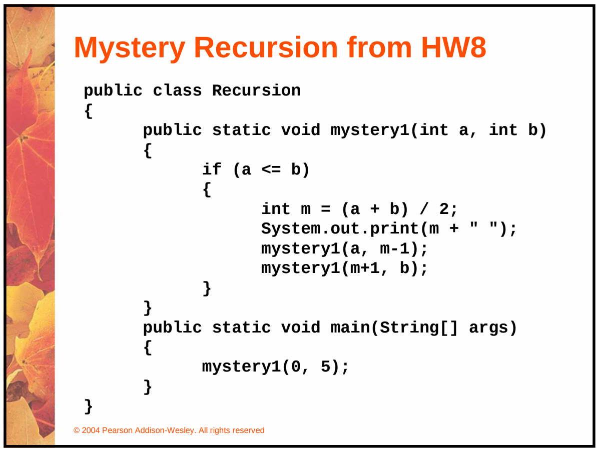


Think of recursion as a tree …



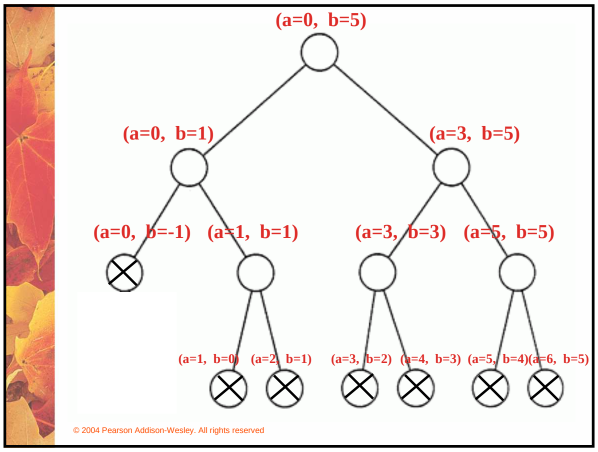
… an upside down tree

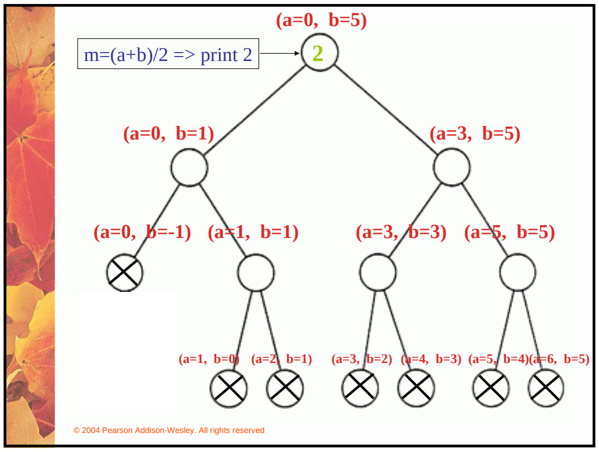


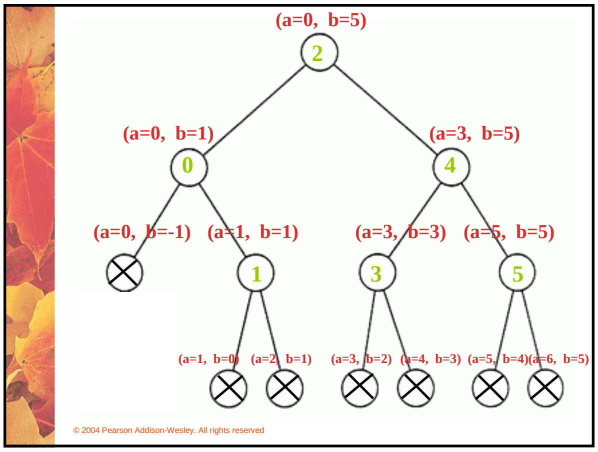


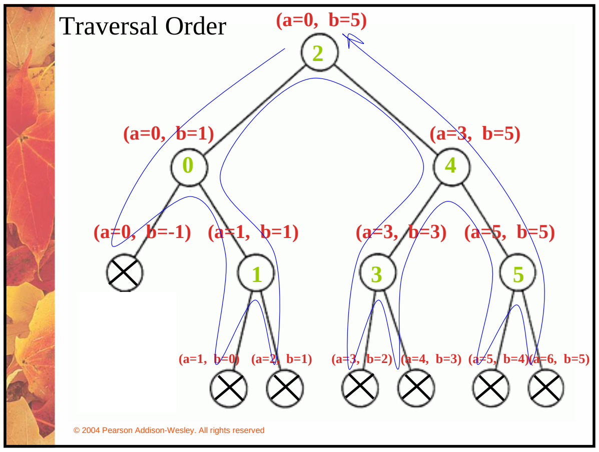
Mystery Recursion from HW8

```
public class Recursion
{
        public static void mystery1(int a, int b)
        {
                if (a <= b)
                {
                        int m = (a + b) / 2;
                        System.out.print(m + " ");
                        mystery1(a, m-1);
                        mystery1(m+1, b);
                }
        }
        public static void main(String[] args)
        {
                mystery1(0, 5);
        }
}
```

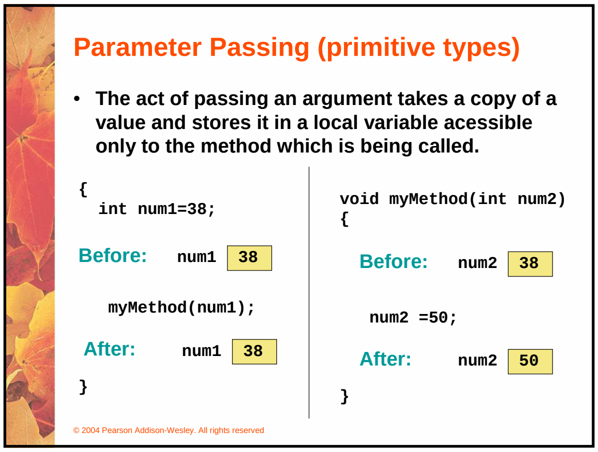








Traversal Order

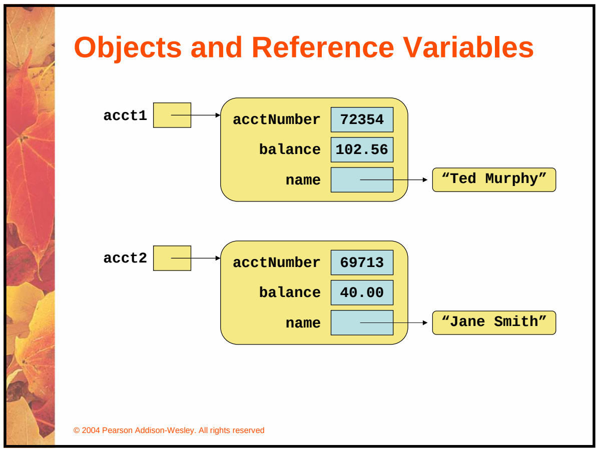


Parameter Passing (primitive types)

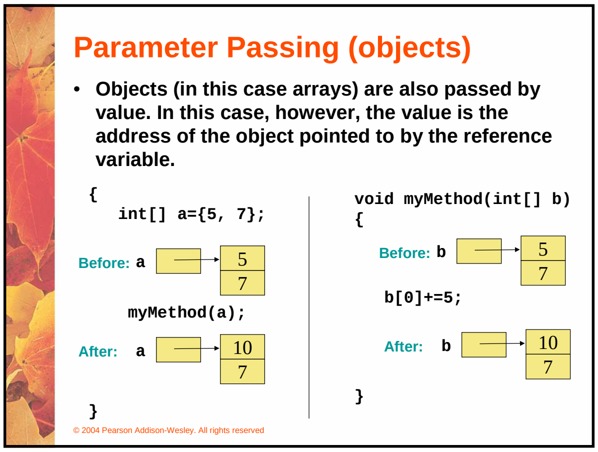
- The act of passing an argument takes a copy of a value and stores it in a local variable acessible only to the method which is being called.

```
{
  int num1=38;

Before:   num1  38

   myMethod(num1);

 After:   num1  38
}
```

```
void myMethod(int num2)
{

  Before:   num2  38

     num2 =50;

  After:    num2  50
}
```



Objects and Reference Variables

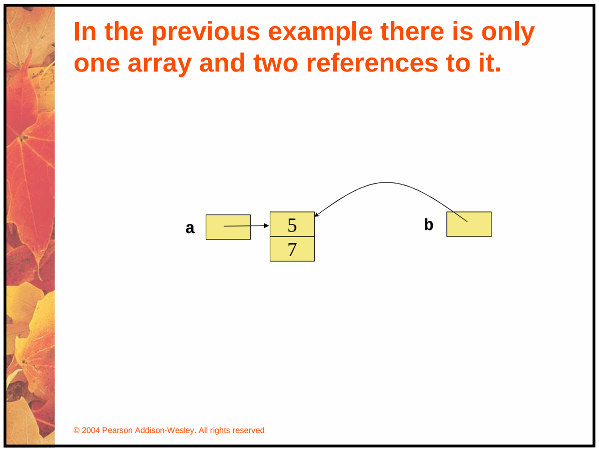


Parameter Passing (objects)

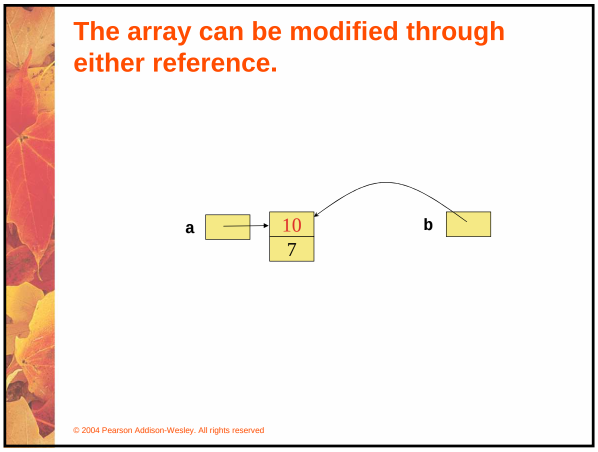
- Objects (in this case arrays) are also passed by value. In this case, however, the value is the address of the object pointed to by the reference variable.

```
{
   int[] a={5, 7};

    myMethod(a);

}
```

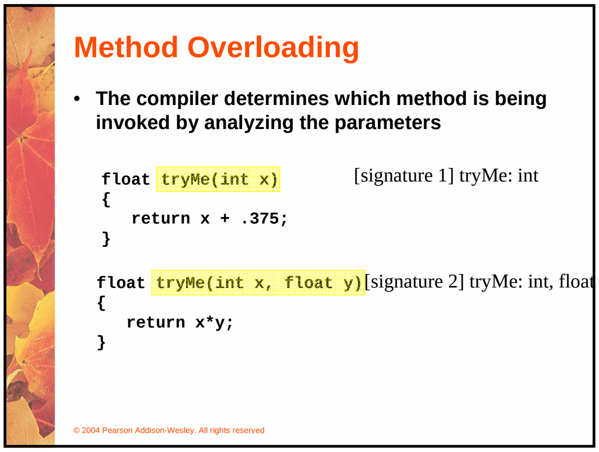
```
void myMethod(int[] b)
{

   b[0]+=5;

}
```



In the previous example there is only one array and two references to it.



The array can be modified through either reference.



Method Overloading

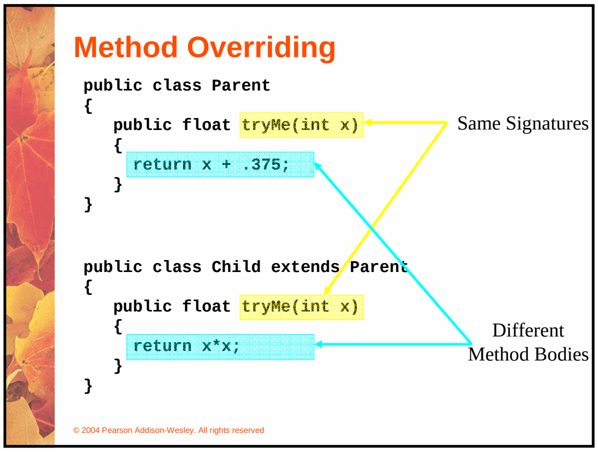
- The compiler determines which method is being invoked by analyzing the parameters

```
float tryMe(int x)
{
    return x + .375;
}
```

[signature 1] tryMe: int

```
float tryMe(int x, float y)
{
    return x*y;
}
```

[signature 2] tryMe: int, float



Method Overriding

```
public class Parent
{
    public float tryMe(int x)
    {
      return x + .375;
    }
}


public class Child extends Parent
{
    public float tryMe(int x)
    {
      return x*x;
    }
}
```

Same Signatures

Different
Method Bodies

Overloading vs. Overriding

- Overloading deals with multiple methods with the same name in the same class, but with different signatures
- Overriding deals with two methods, one in a parent class and one in a child class, that have the same signature

Overloading vs. Overriding

- Overloading lets you define a similar operation in different ways for different parameters
- Overriding lets you define a similar operation in different ways for different object types

Average Example from HW9

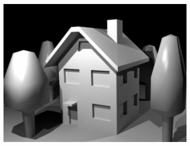
```
public class Average
{
   public static double average(double a, double b)
   {
       return (a+b)/2.0;
   }

   public static double average(double a, double b, double c)
   {
       return (a+b+c)/3.0;
   }

   public static void main (String[] args)
   {
      System.out.println (average(1, 2));
      System.out.println (average (1, 2, 3));
   }
}
```

Aggregation Example: Copmonents of a Student

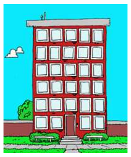
Student

First Name

Last Name



Home Address



School Address

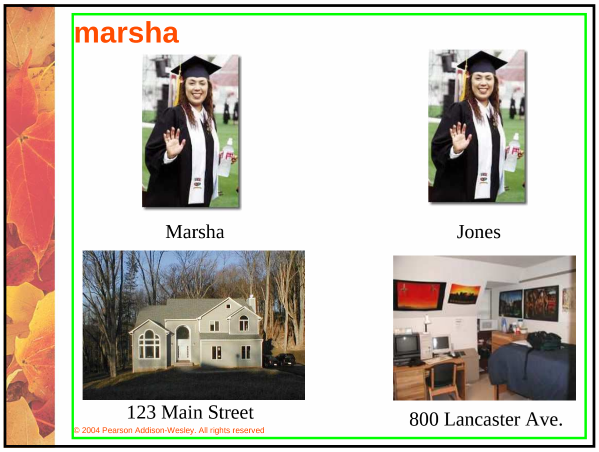
john

John

Smith

21 Jump Street

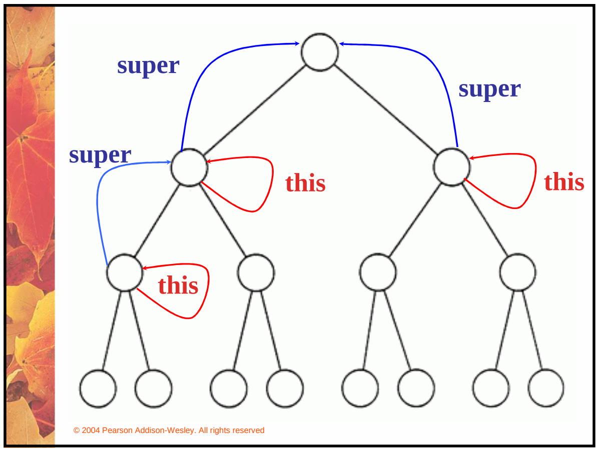
800 Lancaster Ave.

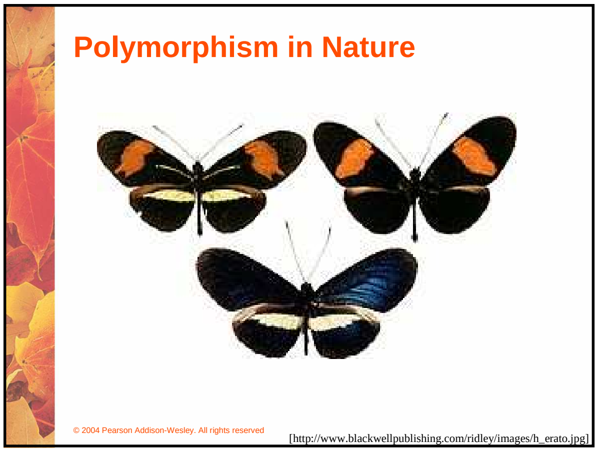


marsha

Aggregation

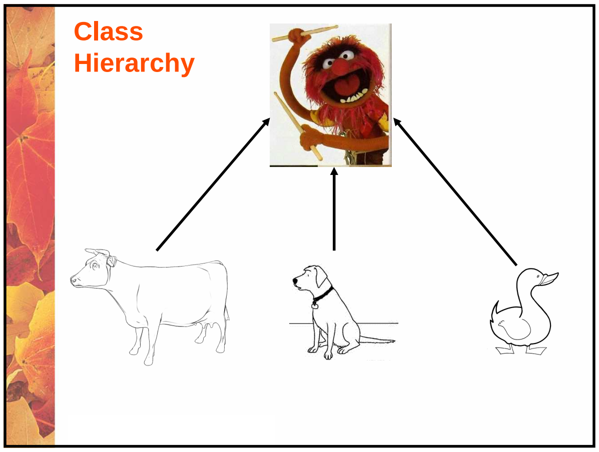
- In the following example, a `Student` object is composed, in part, of `Address` objects
- A student has an address (in fact each student has two addresses)
- See StudentBody.java (page 304)
- See Student.java (page 306)
- See Address.java (page 307)
- An aggregation association is shown in a UML class diagram using an open diamond at the aggregate end



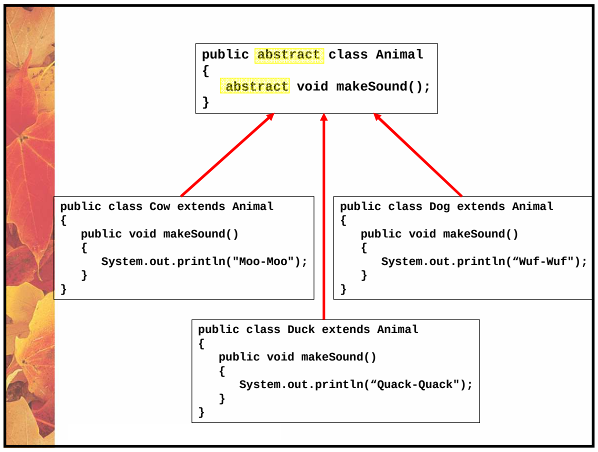


Polymorphism in Nature

[http://www.blackwellpublishing.com/ridley/images/h_erato.jpg]



Class Hierarchy

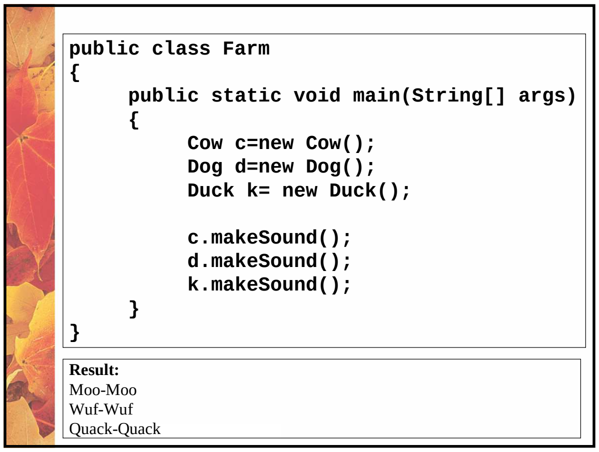


```
public abstract class Animal
{
  abstract void makeSound();
}
```

```
public class Cow extends Animal
{
   public void makeSound()
   {
      System.out.println("Moo-Moo");
   }
}
```

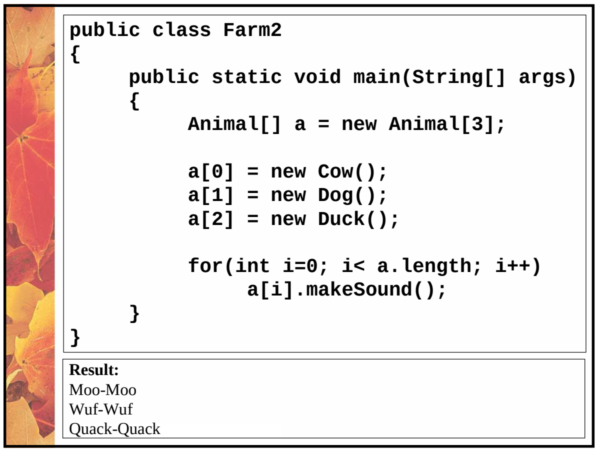
```
public class Dog extends Animal
{
   public void makeSound()
   {
      System.out.println(“Wuf-Wuf");
   }
}
```

```
public class Duck extends Animal
{
   public void makeSound()
   {
      System.out.println(“Quack-Quack");
   }
}
```



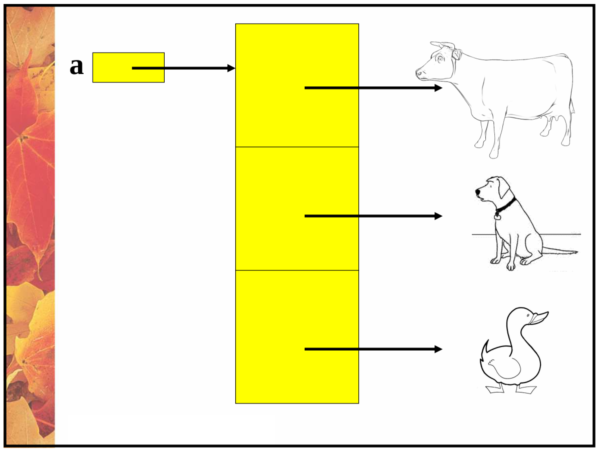
```
public class Farm
{
      public static void main(String[] args)
      {
            Cow c=new Cow();
            Dog d=new Dog();
            Duck k= new Duck();

            c.makeSound();
            d.makeSound();
            k.makeSound();
      }
}
```

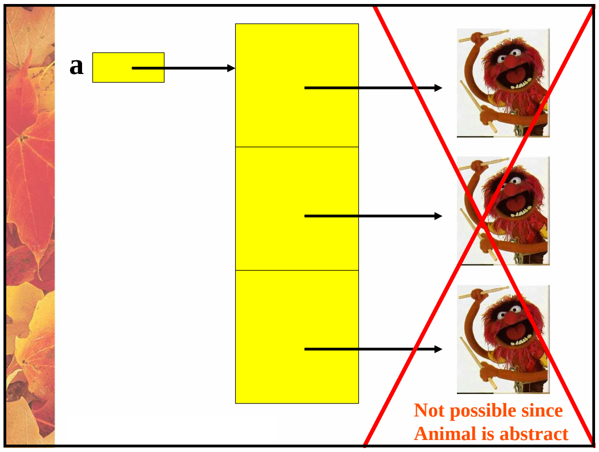
Result:
Moo-Moo
Wuf-Wuf
Quack-Quack



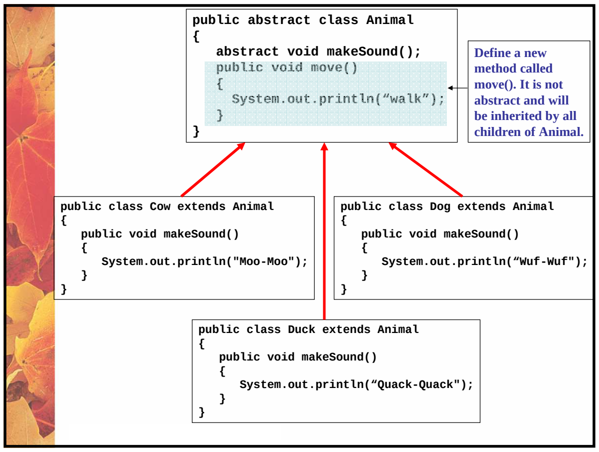
```
public class Farm2
{
      public static void main(String[] args)
      {
            Animal[] a = new Animal[3];

            a[0] = new Cow();
            a[1] = new Dog();
            a[2] = new Duck();

            for(int i=0; i< a.length; i++)
                  a[i].makeSound();
      }
}
```

Result:
Moo-Moo
Wuf-Wuf
Quack-Quack





Not possible since
Animal is abstract



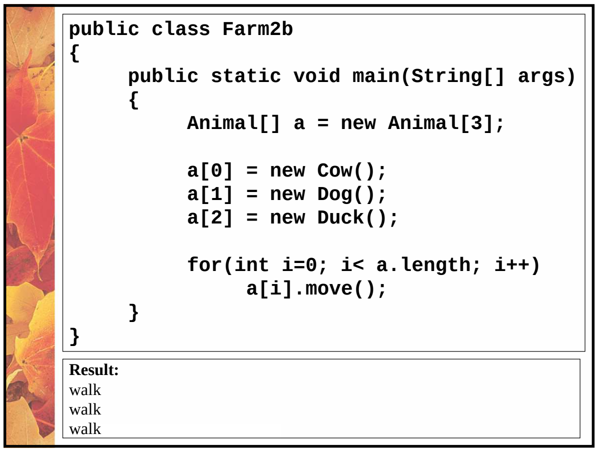
```
public abstract class Animal
{
   abstract void makeSound();
   public void move()
   {
     System.out.println(“walk”);
   }
}
```

Define a new method called move(). It is not abstract and will be inherited by all children of Animal.

```
public class Cow extends Animal
{
   public void makeSound()
   {
      System.out.println("Moo-Moo");
   }
}
```

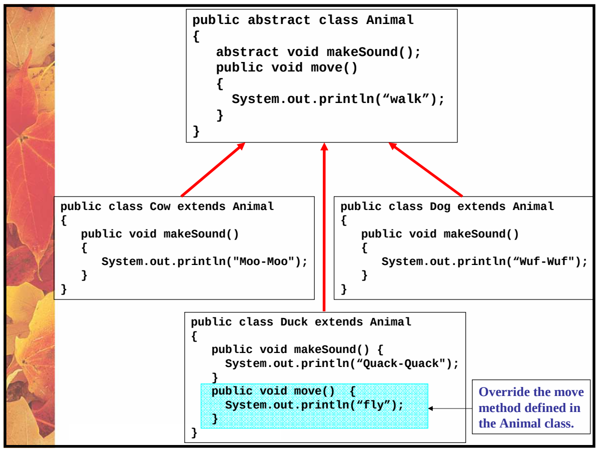
```
public class Dog extends Animal
{
   public void makeSound()
   {
      System.out.println(“Wuf-Wuf");
   }
}
```

```
public class Duck extends Animal
{
   public void makeSound()
   {
      System.out.println(“Quack-Quack");
   }
}
```



```
public class Farm2b
{
      public static void main(String[] args)
      {
            Animal[] a = new Animal[3];

            a[0] = new Cow();
            a[1] = new Dog();
            a[2] = new Duck();

            for(int i=0; i< a.length; i++)
                  a[i].move();
      }
}
```

Result:
walk
walk
walk



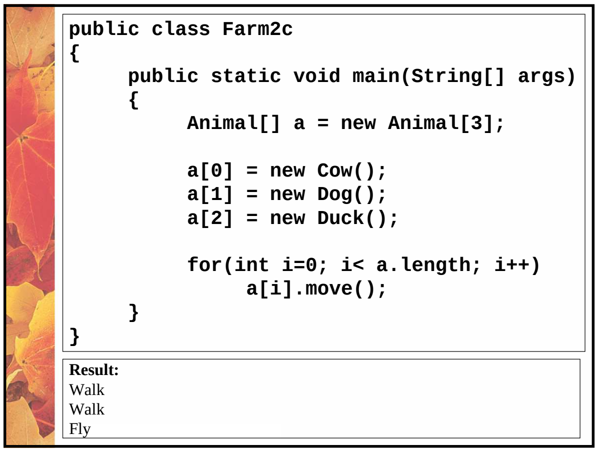
```
public abstract class Animal
{
   abstract void makeSound();
   public void move()
   {
     System.out.println(“walk”);
   }
}
```

```
public class Cow extends Animal
{
   public void makeSound()
   {
      System.out.println("Moo-Moo");
   }
}
```

```
public class Dog extends Animal
{
   public void makeSound()
   {
      System.out.println(“Wuf-Wuf");
   }
}
```

```
public class Duck extends Animal
{
   public void makeSound() {
     System.out.println(“Quack-Quack");
   }
   public void move()  {
     System.out.println(“fly”);
   }
}
```

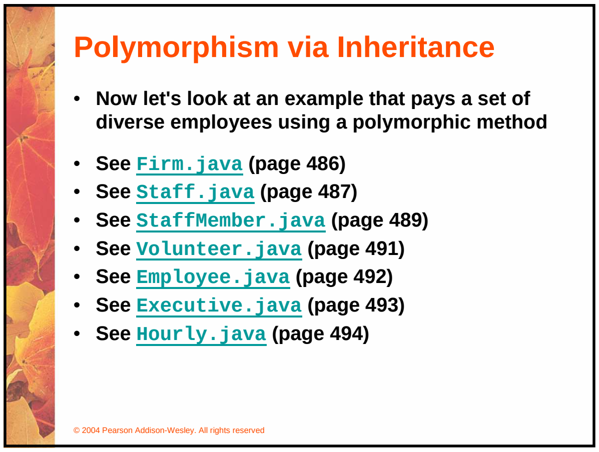
Override the move method defined in the Animal class.



```
public class Farm2c
{
     public static void main(String[] args)
     {
          Animal[] a = new Animal[3];

          a[0] = new Cow();
          a[1] = new Dog();
          a[2] = new Duck();

          for(int i=0; i< a.length; i++)
               a[i].move();
     }
}
```

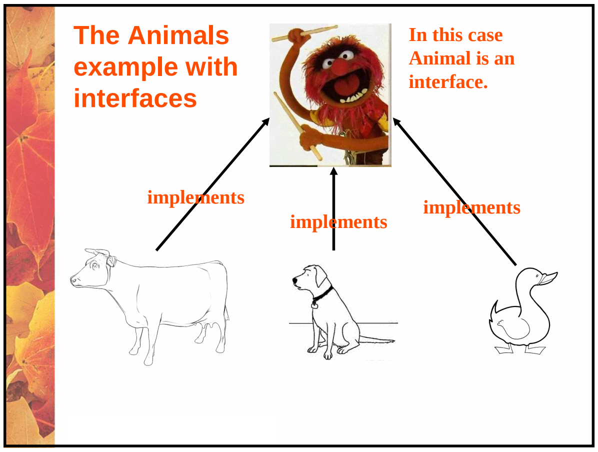
Result:

```
Walk
Walk
Fly
```



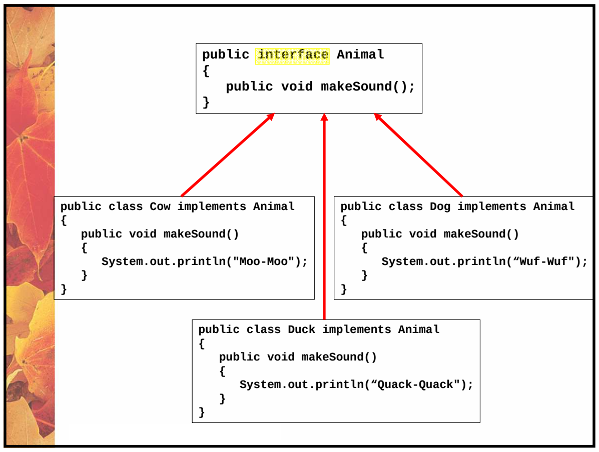
Polymorphism via Inheritance

- Now let's look at an example that pays a set of diverse employees using a polymorphic method
- See `Firm.java` (page 486)
- See `Staff.java` (page 487)
- See `StaffMember.java` (page 489)
- See `Volunteer.java` (page 491)
- See `Employee.java` (page 492)
- See `Executive.java` (page 493)
- See `Hourly.java` (page 494)



The Animals example with interfaces

In this case Animal is an interface.

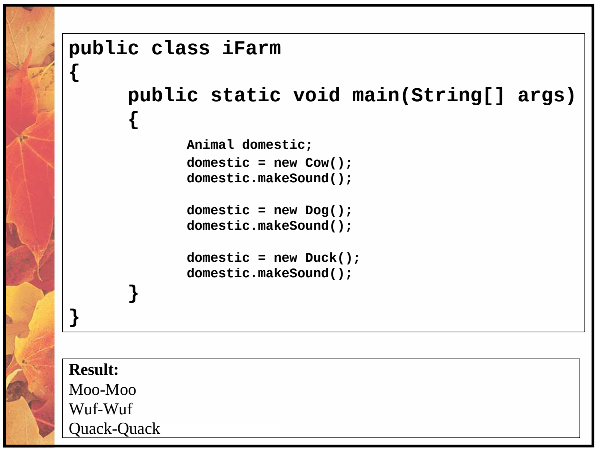


```
public interface Animal
{
   public void makeSound();
}
```

```
public class Cow implements Animal
{
   public void makeSound()
   {
      System.out.println("Moo-Moo");
   }
}
```

```
public class Dog implements Animal
{
   public void makeSound()
   {
      System.out.println(“Wuf-Wuf");
   }
}
```

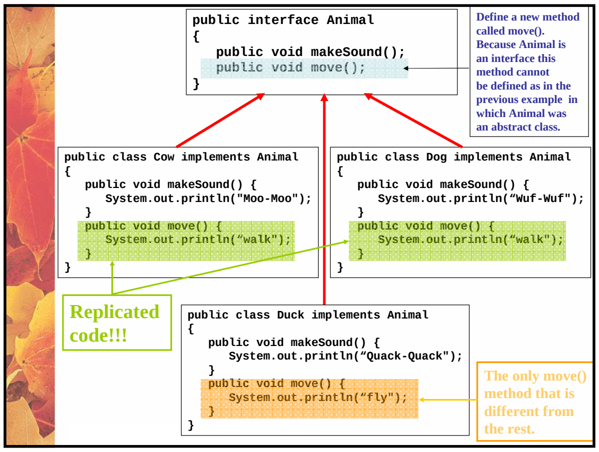
```
public class Duck implements Animal
{
   public void makeSound()
   {
      System.out.println(“Quack-Quack");
   }
}
```



```
public class iFarm
{
     public static void main(String[] args)
     {
          Animal domestic;
          domestic = new Cow();
          domestic.makeSound();

          domestic = new Dog();
          domestic.makeSound();

          domestic = new Duck();
          domestic.makeSound();
     }
}
```

Result:

```
Moo-Moo
Wuf-Wuf
Quack-Quack
```



```
public interface Animal
{
   public void makeSound();
   public void move();
}
```

Define a new method called move(). Because Animal is an interface this method cannot be defined as in the previous example in which Animal was an abstract class.

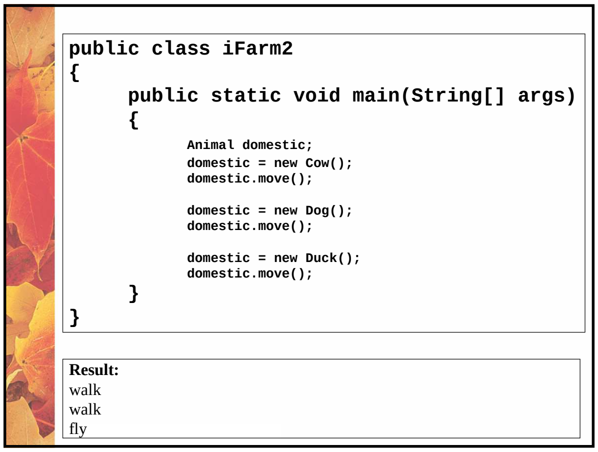
```
public class Cow implements Animal
{
   public void makeSound() {
      System.out.println("Moo-Moo");
   }
   public void move() {
      System.out.println(“walk");
   }
}
```

```
public class Dog implements Animal
{
   public void makeSound() {
      System.out.println(“Wuf-Wuf");
   }
   public void move() {
      System.out.println(“walk");
   }
}
```

Replicated code!!!

```
public class Duck implements Animal
{
   public void makeSound() {
      System.out.println(“Quack-Quack");
   }
   public void move() {
      System.out.println(“fly");
   }
}
```

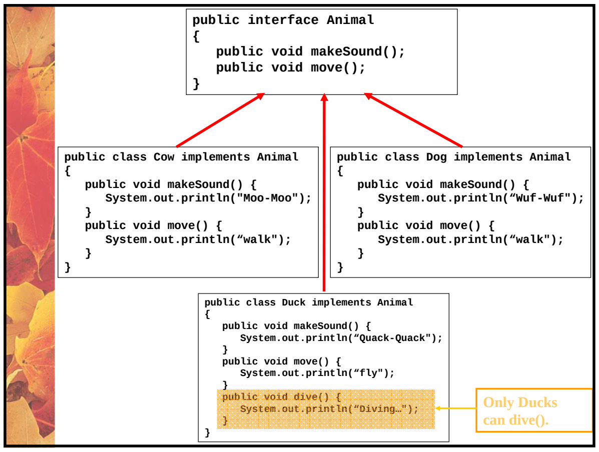
The only move() method that is different from the rest.



```
public class iFarm2
{
      public static void main(String[] args)
      {
            Animal domestic;
            domestic = new Cow();
            domestic.move();

            domestic = new Dog();
            domestic.move();

            domestic = new Duck();
            domestic.move();
      }
}
```

Result:

```
walk
walk
fly
```



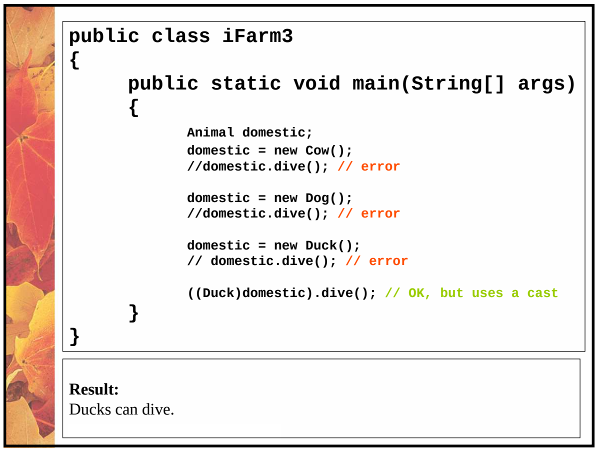
```
public interface Animal
{
   public void makeSound();
   public void move();
}
```

```
public class Cow implements Animal
{
   public void makeSound() {
      System.out.println("Moo-Moo");
   }
   public void move() {
      System.out.println(“walk");
   }
}
```

```
public class Dog implements Animal
{
   public void makeSound() {
      System.out.println(“Wuf-Wuf");
   }
   public void move() {
      System.out.println(“walk");
   }
}
```

```
public class Duck implements Animal
{
   public void makeSound() {
      System.out.println(“Quack-Quack");
   }
   public void move() {
      System.out.println(“fly");
   }
   public void dive() {
      System.out.println(“Diving…");
   }
}
```

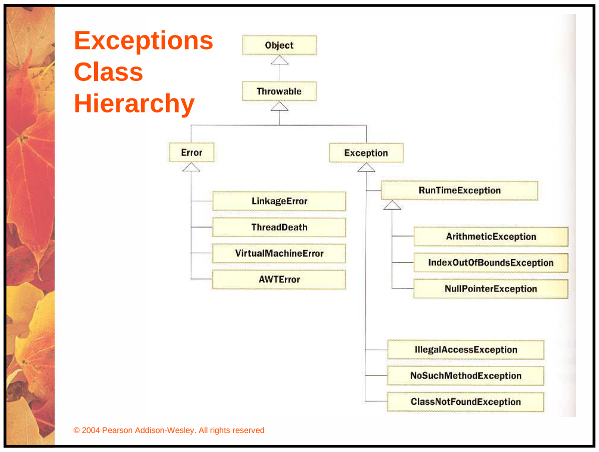
Only Ducks can dive().



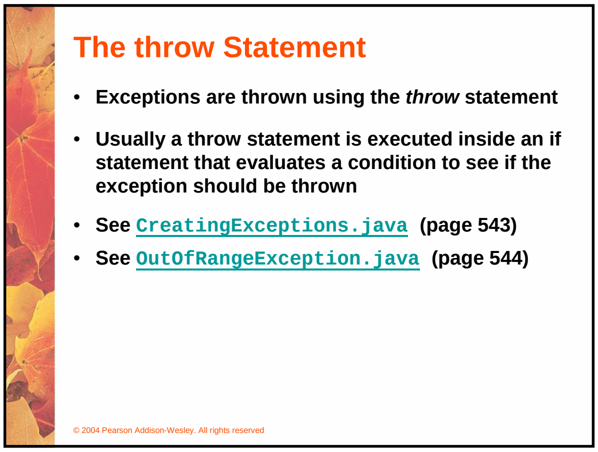
```
public class iFarm3
{
      public static void main(String[] args)
      {
            Animal domestic;
            domestic = new Cow();
            //domestic.dive(); // error

            domestic = new Dog();
            //domestic.dive(); // error

            domestic = new Duck();
            // domestic.dive(); // error

            ((Duck)domestic).dive(); // OK, but uses a cast
      }
}
```

Result:

```
Ducks can dive.
```

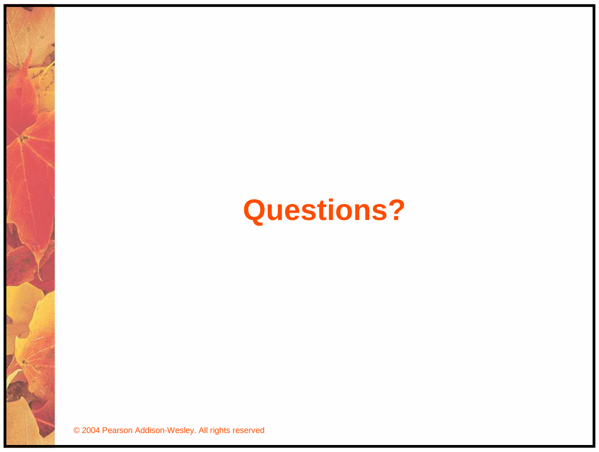


Exceptions Class Hierarchy

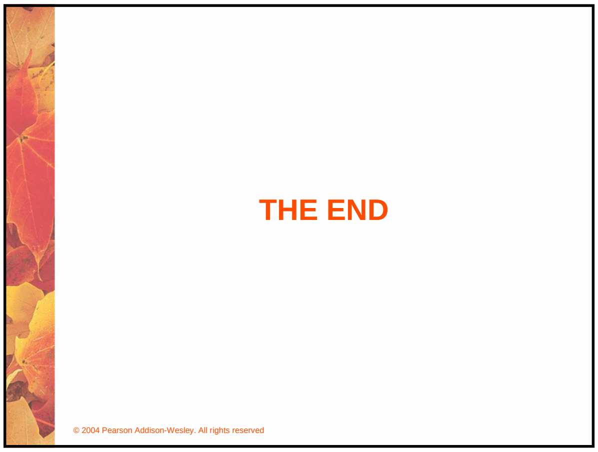


The throw Statement

- Exceptions are thrown using the *throw* statement
- Usually a throw statement is executed inside an if statement that evaluates a condition to see if the exception should be thrown
- See `CreatingExceptions.java` (page 543)
- See `OutOfRangeException.java` (page 544)



Questions?



THE END