Chapter 6 - Object-Oriented Programming: Inheritance

Introduction

- Inheritance
  - Software reusability
  - Create new class from existing class
    - Absorb existing class's data and behaviors
    - Enhance with new capabilities
  - Subclass extends superclass
    - Subclass
      - More specialized group of objects
      - Behaviors inherited from superclass
        - Can customize
      - Additional behaviors

Introduction

- Class hierarchy
  - Direct superclass
    - Inherited explicitly (one level up hierarchy)
  - Indirect superclass
    - Inherited two or more levels up hierarchy
  - Single inheritance
    - Inherits from one superclass
  - Multiple inheritance
    - Inherits from multiple superclasses
      - Java does not support multiple inheritance

Introduction

- Abstraction
  - Focus on commonalities among objects in system
- “is-a” vs. “has-a”
  - “is-a”
    - Inheritance
    - subclass object treated as superclass object
    - Example: Car *is a* vehicle
      - Vehicle properties/behaviors also car properties/behaviors
  - “has-a”
    - Composition
    - Object contains one or more objects of other classes as members
    - Example: Car *has a* steering wheel

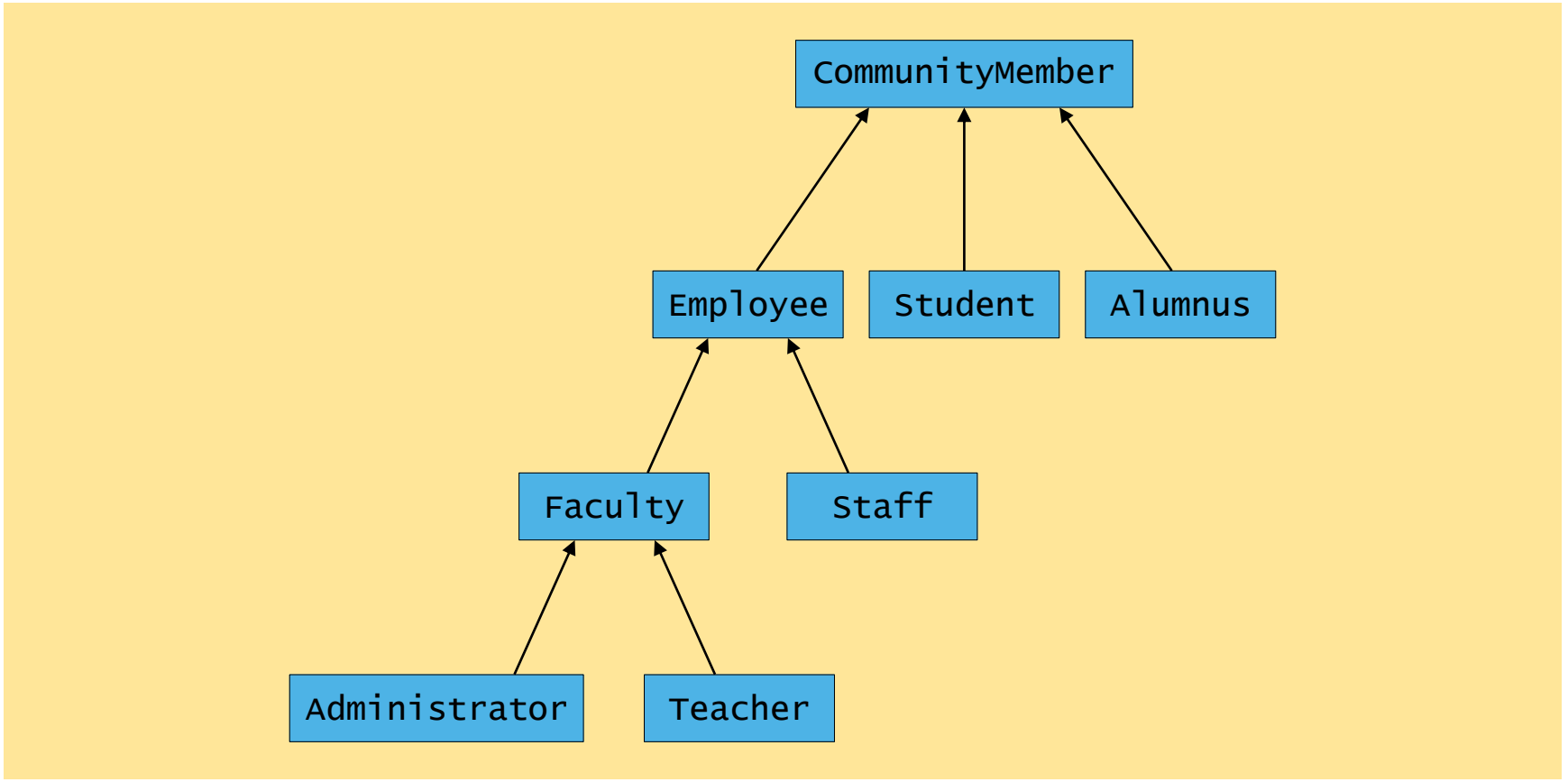
Superclasses and Subclasses

- Superclasses and subclasses
  - Object of one class "is an" object of another class
    - Example: Rectangle is quadrilateral.
      - Class `Rectangle` inherits from class `Quadrilateral`
      - `Quadrilateral`: superclass
      - `Rectangle`: subclass
  - Superclass typically represents larger set of objects than subclasses
    - Example:
      - superclass: `Vehicle`
        - Cars, trucks, boats, bicycles, …
      - subclass: `Car`
        - Smaller, more-specific subset of vehicles

Superclasses and Subclasses (Cont.)

- Inheritance hierarchy
  - Inheritance relationships: tree-like hierarchy structure
  - Each class becomes
    - superclass
      - Supply data/behaviors to other classes

    OR
    - subclass
      - Inherit data/behaviors from other classes



Inheritance hierarchy for university `CommunityMember`s.

`protected` Members

- `protected` access
  - Intermediate level of protection between `public` and `private`
  - `protected` members accessible to
    - superclass members
    - subclass members
    - Class members in the same package
  - Subclass access superclass member
    - Keyword `super` and a dot (.)

Relationship between Superclasses and Subclasses

- Superclass and subclass relationship
  - Example: Point/circle inheritance hierarchy
    - Point
      - x-y coordinate pair
    - Circle
      - x-y coordinate pair
      - Radius

```
1
2
3
4  public class Point {
5     private int x; // x part of coordinate pair
6     private int y; // y part of coordinate pair
7
8     // no-argument constructor
9     public Point()
10    {
11       // implicit call to Object constructor occurs here
12    }
13
14    // constructor
15    public Point( int xValue, int yValue )
16    {
17       // implicit call to Object constructor occurs here
18       x = xValue;  // no need for validation
19       y = yValue;  // no need for validation
20    }
21
22    // set x in coordinate pair
23    public void setX( int xValue )
24    {
25       x = xValue;  // no need for validation
26    }
27
```

Maintain x- and y-coordinates as `private` instance variables.

Implicit call to Object constructor

```
28    // return x from coordinate pair
29    public int getX()
30    {
31       return x;
32    }
33
34    // set y in coordinate pair
35    public void setY( int yValue )
36    {
37       y = yValue;  // no need for validation
38    }
39
40    // return y from coordinate pair
41    public int getY()
42    {
43       return y;
44    }
45
46    // return String representation of Point object
47    public String toString()
48    {
49       return "[" + x + ", " + y + "]";
50    }
51
52 } // end class Point
```

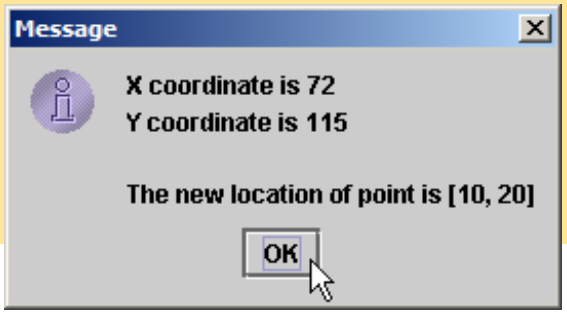
Override method `toString` of class `Object`

```
1  // Fig. 9.5: PointTest.java
2  // Testing class Point.
3  import javax.swing.JOptionPane;
4
5  public class PointTest {
6
7     public static void main( String[] args )
8     {
9        Point point = new Point( 72, 115 ); // create Point object
10
11       // get point coordinates
12       String output = "X coordinate is "
13          "\nY coordinate is " + point.get
14
15       point.setX( 10 );  // set x-coordinate
16       point.setY( 20 );  // set y-coordinate
17
18       // get String representation of new point value
19       output += "\n\nThe new location of point is " + point;
20
21       JOptionPane.showMessageDialog( null, output ); // display output
22
23       System.exit( 0 );
24
25    } // end main
26
27 } // end class PointTest
```

Instantiate `Point` object

Change the value of point's x- and y- coordinates

Implicitly call point's `toString` method



```
1  // Fig. 9.8: Circle2.java
2  // Circle2 class inherits from Point.
3
4  public class Circle2 extends Point {
5     private double radius;  // Circle2's radius
6
7     // no-argument constructor
8     public Circle2()
9     {
10       // implicit call to Point constructor occurs here
11    }
12
13    // constructor
14    public Circle2( int xValue, int yVal
15    {
16       // implicit call to Point constru
17       x = xValue;  // not allowed: x pr
18       y = yValue;  // not allowed: y private in Point
19       setRadius( radiusValue );
20    }
21
22    // set radius
23    public void setRadius( double radiusValue )
24    {
25       radius = ( radiusValue < 0.0 ? 0.0 : radiusValue );
26    }
27
```

Class `Circle2` extends class `Point`.

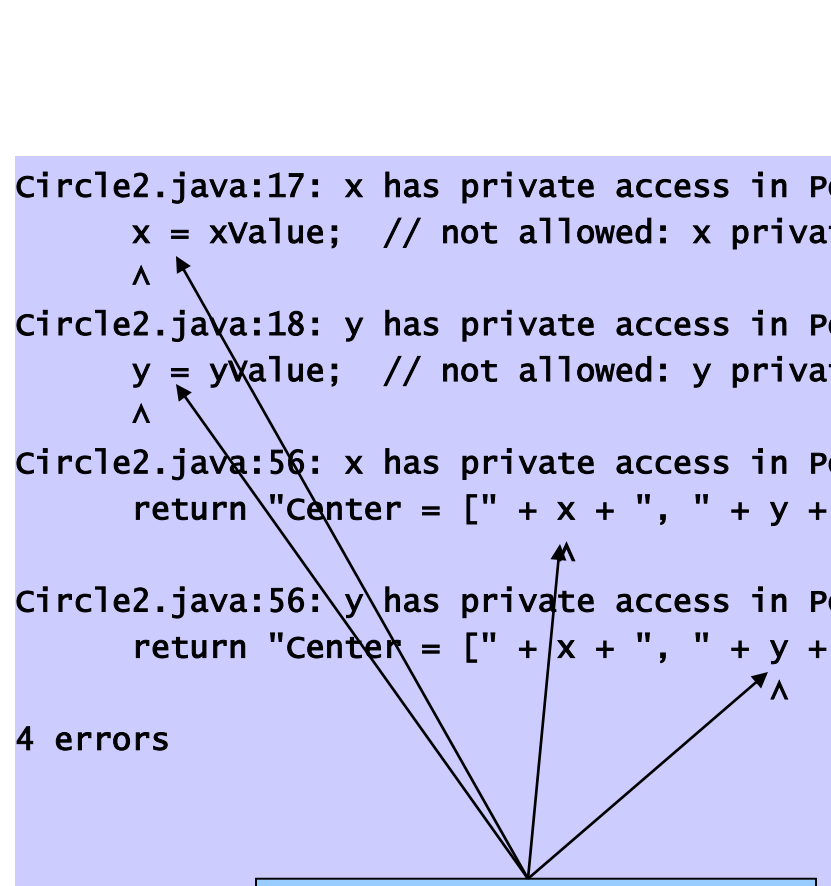
Maintain `private` instance variable `radius`.

Attempting to access superclass `Point`'s `private` instance variables `x` and `y` results in syntax errors.

```
34       // calculate and return diameter
35       public double getDiameter()
36       {
37          return 2 * radius;
38       }
39
40       // calculate and return circumference
41       public double getCircumference()
42       {
43          return Math.PI * getDiameter();
44       }
45
46       // calculate and return area
47       public double getArea()
48       {
49          return Math.PI * radius * radius;
50       }
51
52       // return String representation of Circle object
53       public String toString()
54       {
55          // use of x and y not allowed: x and y private
56          return "Center = [" + x + ", " + y + "]; Radius = " + radius;
57       }
58
59    } // end class Circle2
```

Attempting to access superclass `Point`'s `private` instance variables `x` and `y` results in syntax errors.

```
Circle2.java:17: x has private access in Point
      x = xValue;  // not allowed: x private in Point
      ^
Circle2.java:18: y has private access in Point
      y = yValue;  // not allowed: y private in Point
      ^
Circle2.java:56: x has private access in Point
      return "Center = [" + x + ", " + y + "]; Radius = " + radius;
                            ^
Circle2.java:56: y has private access in Point
      return "Center = [" + x + ", " + y + "]; Radius = " + radius;
                                   ^
4 errors
```



Attempting to access superclass `Point`'s `private` instance variables `x` and `y` results in syntax errors.

```
1  // Fig. 9.9: Point2.java
2  // Point2 class declaration represent
3
4  public class Point2 {
5     protected int x;  // x part of coo
6     protected int y;  // y part of coo
7
8     // no-argument constructor
9     public Point2()
10    {
11       // implicit call to Object constructor occurs here
12    }
13
14    // constructor
15    public Point2( int xValue, int yValue )
16    {
17       // implicit call to Object constructor occurs here
18       x = xValue;  // no need for validation
19       y = yValue;  // no need for validation
20    }
21
22    // set x in coordinate pair
23    public void setX( int xValue )
24    {
25       x = xValue;  // no need for validation
26    }
27
```

Maintain `x`- and `y`-coordinates as `protected` instance variables, accessible to subclasses.

```
28     // return x from coordinate pair
29     public int getX()
30     {
31        return x;
32     }
33
34     // set y in coordinate pair
35     public void setY( int yValue )
36     {
37        y = yValue;  // no need for validation
38     }
39
40     // return y from coordinate pair
41     public int getY()
42     {
43        return y;
44     }
45
46     // return String representation of Point2 object
47     public String toString()
48     {
49        return "[" + x + ", " + y + "]";
50     }
51
52  } // end class Point2
```

```
1  // Fig. 9.10: Circle3.java
2  // Circle3 class inherits from Point2 and ha
3  // protected members x and y.
4
5  public class Circle3 extends Point2 {
6     private double radius; // Circle3's radius
7
8     // no-argument constructor
9     public Circle3()
10    {
11       // implicit call to Point2 constructor occurs here
12    }
13
14    // constructor
15    public Circle3( int xValue, int
16    {
17       // implicit call to Point2 c
18       x = xValue; // no need for
19       y = yValue; // no need for
20       setRadius( radiusValue );
21    }
22
23    // set radius
24    public void setRadius( double radiusValue )
25    {
26       radius = ( radiusValue < 0.0 ? 0.0 : radiusValue );
27    }
28
```

Class `Circle3` inherits from

Maintain `private` instance variables `radius`.

Implicitly calls superclass's default constructor.

Modify inherited instance variables `x` and `y`, declared `protected` in superclass `Point2`.

```
29      // return radius
30      public double getRadius()
31      {
32         return radius;
33      }
34
35      // calculate and return diameter
36      public double getDiameter()
37      {
38         return 2 * radius;
39      }
40
41      // calculate and return circumference
42      public double getCircumference()
43      {
44         return Math.PI * getDiameter();
45      }
46
47      // calculate and return area
48      public double getArea()
49      {
50         return Math.PI * radius * radius;
51      }
52
53      // return String representation of Circle3 object
54      public String toString()
55      {
56         return "Center = [" + x + ", " + y + "]; Radius = " + radius;
57      }
58
59   } // end class Circle3
```

Access inherited instance variables `x` and `y`, declared `protected` in superclass `Point2`.

```
1  // Fig. 9.11: CircleTest3.java
2  // Testing class Circle3.
3  import java.text.DecimalFormat;
4  import javax.swing.JOptionPane;
5
6  public class CircleTest3 {
7
8     public static void main( String[] args )
9     {
10       // instantiate Circle object
11       Circle3 circle = new Circle3( 37, 43, 2.5 );
12
13       // get Circle3's initial x-y coordinates and radius
14       String output = "X coordinate is " + circle.getX() +
15          "\nY coordinate is " + circle.getY() +
16          "\nRadius is " + circle.getRadius();
17
18       circle.setX( 35 );          // set new x-coordinate
19       circle.setY( 20 );          // set new y-coordinate
20       circle.setRadius( 4.25 );   // set new rad
21
22       // get String representation of
23       output += "\n\nThe new location a
24          circle.toString();
25
```

Create `Circle3` object.

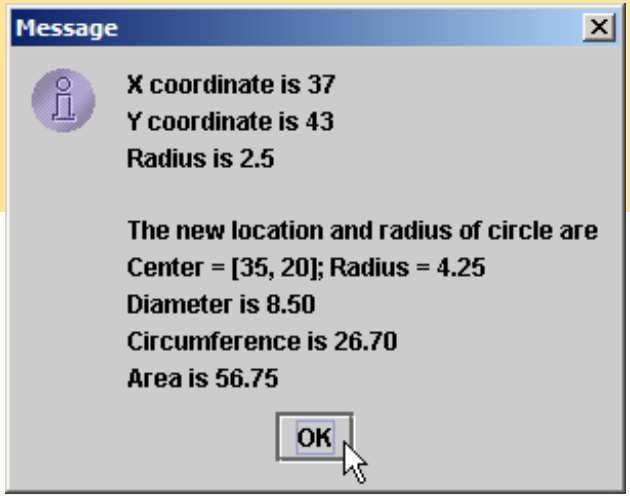
Use `Circle3` get method to access `private` instance variables.

Use inherited set methods to modify inherited

nd y.

Use `Circle3` set method to modify `private` data `radius`.

```
26         // format floating-point values with 2 digits of precision
27         DecimalFormat twoDigits = new DecimalFormat( "0.00" );
28
29         // get Circle's diameter
30         output += "\nDiameter is " +
31            twoDigits.format( circle.getDiameter() );
32
33         // get Circle's circumference
34         output += "\nCircumference is " +
35            twoDigits.format( circle.getCircumference() );
36
37         // get Circle's area
38         output += "\nArea is " + twoDigits.format( circle.getArea() );
39
40         JOptionPane.showMessageDialog( null, output ); // display output
41
42         System.exit( 0 );
43
44      } // end method main
45
46   } // end class CircleTest3
```



Relationship between Superclasses and Subclasses (Cont.)

- Using `protected` instance variables
  - Advantages
    - subclasses can modify values directly
    - Slight increase in performance
      - Avoid set/get function call overhead
  - Disadvantages
    - No validity checking
      - subclass can assign illegal value
    - Implementation dependent
      - subclass methods more likely dependent on superclass implementation
      - superclass implementation changes may result in subclass modifications
        - Fragile (brittle) software

```
1  // Fig. 9.12: Point3.java
2  // Point class declaration represen
3
4  public class Point3 {
5     private int x;  // x part of coo
6     private int y;  // y part of coordinate pair
7
8     // no-argument constructor
9     public Point3()
10    {
11       // implicit call to Object constructor occurs here
12    }
13
14    // constructor
15    public Point3( int xValue, int yValue )
16    {
17       // implicit call to Object constructor occurs here
18       x = xValue;  // no need for validation
19       y = yValue;  // no need for validation
20    }
21
22    // set x in coordinate pair
23    public void setX( int xValue )
24    {
25       x = xValue;  // no need for validation
26    }
27
```

Better software-engineering practice: `private` over `protected` when possible.

```
28    // return x from coordinate pair
29    public int getX()
30    {
31       return x;
32    }
33
34    // set y in coordinate pair
35    public void setY( int yValue )
36    {
37       y = yValue;  // no need for validation
38    }
39
40    // return y from coordinate pair
41    public int getY()
42    {
43       return y;
44    }
45
46    // return String representation of Point3
47    public String toString()
48    {
49       return "[" + getX() + ", " + getY() + "]";
50    }
51
52 } // end class Point3
```

Invoke `public` methods to access `private` instance variables.

```
1  // Fig. 9.13: Circle4.java
2  // Circle4 class inherits from Point3 and ac
3  // private x and y via Point3's public metho
4
5  public class Circle4 extends Point3 {
6
7     private double radius; // Circle4's radius
8
9     // no-argument constructor
10    public Circle4()
11    {
12       // implicit call to Point3 constructor occurs here
13    }
14
15    // constructor
16    public Circle4( int xValue, int yValue, double radiusValue )
17    {
18       super( xValue, yValue );  // call Point3 constructor explicitly
19       setRadius( radiusValue );
20    }
21
22    // set radius
23    public void setRadius( double radiusValue )
24    {
25       radius = ( radiusValue < 0.0 ? 0.0 : radiusValue );
26    }
27
```

Class `Circle4` inherits from class `Point3`.

Maintain `private` instance variable `radius`.

```
28      // return radius
29      public double getRadius()
30      {
31         return radius;
32      }
33
34      // calculate and return diameter
35      public double getDiameter()
36      {
37         return 2 * getRadius();
38      }
39
40      // calculate and return circumference
41      public double getCircumference()
42      {
43         return Math.PI * getDiameter();
44      }
45
46      // calculate and return area
47      public double getArea()
48      {
49         return Math.PI * getRadius() * getRadius();
50      }
51
52      // return String representation of Circle4 object
53      public String toString()
54      {
55         return "Center = " + super.toString() + "; Radius = " + getRadius();
56      }
57
58   } // end class Circle4
```

Invoke method `getRadius` rather than directly accessing instance variable `radius`.

Redefine class `Point3`'s method toString.

```
1  // Fig. 9.14: CircleTest4.java
2  // Testing class Circle4.
3  import java.text.DecimalFormat;
4  import javax.swing.JOptionPane;
5
6  public class CircleTest4 {
7
8     public static void main( String[] args )
9     {
10       // instantiate Circle object
11       Circle4 circle = new Circle4( 37, 43, 2.5 );
12
13       // get Circle4's initial x-y coordinates and radius
14       String output = "X coordinate is " + circle.getX() +
15          "\nY coordinate is " + circle.getY() +
16          "\nRadius is " + circle.getRadius();
17
18       circle.setX( 35 );          // set new x-coordinate
19       circle.setY( 20 );          // set new y-c
20       circle.setRadius( 4.25 ); // set new rad
21
22       // get String representation of new circ
23       output += "\n\nThe new location and radi
24          circle.toString();
25
```

Create `Circle4` object.

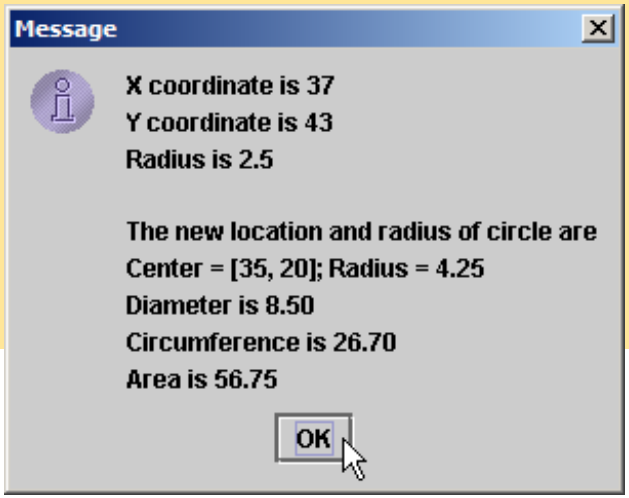
Use inherited get methods to access inherited `private`

Use `Circle4` get method to access `private` instance variable radius.

Use inherited seta methods to modify inherited `private`

Use `Circle4` set method to modify `private` instance variable radius.

```
26         // format floating-point values with 2 digits of precision
27         DecimalFormat twoDigits = new DecimalFormat( "0.00" );
28
29         // get Circle's diameter
30         output += "\nDiameter is " +
31            twoDigits.format( circle.getDiameter() );
32
33         // get Circle's circumference
34         output += "\nCircumference is " +
35            twoDigits.format( circle.getCircumference() );
36
37         // get Circle's area
38         output += "\nArea is " + twoDigits.format( circle.getArea() );
39
40         JOptionPane.showMessageDialog( null, output ); // display output
41
42         System.exit( 0 );
43
44      } // end main
45
46   } // end class CircleTest4
```



Three-Level Inheritance Hierarchy

- Three level point/circle/cylinder hierarchy
  - Point
    - x-y coordinate pair
  - Circle
    - x-y coordinate pair
    - Radius
  - Cylinder
    - x-y coordinate pair
    - Radius
    - Height

```
1  // Fig. 9.15: Cylinder.java
2  // Cylinder class inherits from Circle4.
3
4  public class Cylinder extends Circle4 {
5     private double height;  // Cylinder's height
6
7     // no-argument constructor
8     public Cylinder()
9     {
10       // implicit call to Circle4 constructor occurs here
11    }
12
13    // constructor
14    public Cylinder( int xValue, int yValue, double radiusValue,
15       double heightValue )
16    {
17       super( xValue, yValue, radiusValue ); // call Circle4 constructor
18       setHeight( heightValue );
19    }
20
21    // set Cylinder's height
22    public void setHeight( double heightValue )
23    {
24       height = ( heightValue < 0.0 ? 0.0 : heightValue );
25    }
26
```

Maintain `private` instance variable `height`.

Class `Cylinder` extends class `Circle4`.

```
27    // get Cylinder's height
28    public double getHeight()
29    {
30       return height;
31    }
32
33    // override Circle4 method getArea to ca
34    public double getArea()
35    {
36       return 2 * super.getArea() + getCircumference() * getHeight();
37    }
38
39    // calculate Cylinder volume
40    public double getVolume()
41    {
42       return super.getArea() * getHeight();
43    }
44
45    // return String representation of Cylinde
46    public String toString()
47    {
48       return super.toString() + "; Height = " + getHeight();
49    }
50
51 } // end class Cylinder
```

Redefine superclass

Invoke superclass `Circle4`'s `getArea` method using keyword super.

Redefine class `Circle4`'s

Invoke superclass `Circle4`'s `toString` method using keyword super.

```
1  // Fig. 9.16: CylinderTest.java
2  // Testing class Cylinder.
3  import java.text.DecimalFormat;
4  import javax.swing.JOptionPane;
5
6  public class CylinderTest {
7
8     public static void main( String[] args )
9     {
10       // create Cylinder object
11       Cylinder cylinder = new Cylinder( 12, 23, 2.5, 5.7 );
12
13       // get Cylinder's initial x-y coordinate
14       String output = "X coordinate is " + cyl
15          "\nY coordinate is " + cylinder.getY() +  \nRadius is  +
16          cylinder.getRadius() + "\nHeight is " + cylinder.getHeight();
17
18       cylinder.setX( 35 );              // set new
19       cylinder.setY( 20 );              // set new
20       cylinder.setRadius( 4.25 );       // set new
21       cylinder.setHeight( 10.75 );      // set new
22
23       // get String representation of new cylinc
24       output +=
25          "\n\nThe new location, radius and height of cylinder are\n" +
26          cylinder.toString();
27
```

Invoke indirectly inherited Point3 get methods.

Invoke directly i Circle4 get method.

Invoke Cylinder get method.

Invoke indirectly inherited Point3 set methods.

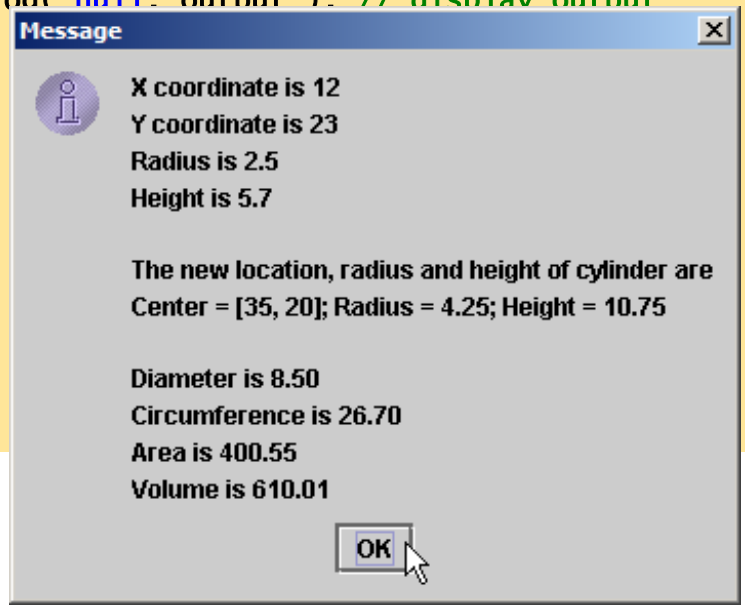
Invoke directly inherited C

Invoke Cylinder set method.

Invoke overridden toString method.

```
28          // format floating-point values with 2 digits of precision
29          DecimalFormat twoDigits = new DecimalFormat( "0.00" );
30
31          // get Cylinder's diameter
32          output += "\n\nDiameter is " +
33             twoDigits.format( cylinder.getDiameter() );
34
35          // get Cylinder's circumference
36          output += "\nCircumference is " +
37             twoDigits.format( cylinder.getCircumference() );
38
39          // get Cylinder's area
40          output += "\nArea is " + twoDigits.format( cylinder.getArea() );
41
42          // get Cylinder's volume
43          output += "\nVolume is " + twoDigits.format( cylinder.getVolume
44
45          JOptionPane.showMessageDialog( null, output ); // display output
46
47          System.exit( 0 );
48
49       } // end main
50
51    } // end class CylinderTest
```

Invoke overridden `getArea` method.



Constructors and Finalizers in Subclasses

- Instantiating subclass object
  - Chain of constructor calls
    - subclass constructor invokes superclass constructor
      - Implicitly or explicitly
    - Base of inheritance hierarchy
      - Last constructor called in chain is `Object`'s constructor
      - Original subclass constructor's body finishes executing last
      - Example: `Point3`/`Circle4`/`Cylinder` hierarchy
        - `Point3` constructor called second last (last is `Object` constructor)
        - `Point3` constructor's body finishes execution second (first is `Object` constructor's body)

Constructors and Destructors in Derived Classes

- Garbage collecting subclass object
  - Chain of `finalize` method calls
    - Reverse order of constructor chain
    - Finalizer of subclass called first
    - Finalizer of next superclass up hierarchy next
      - Continue up hierarchy until final superreached
        - After final superclass (`Object`) finalizer, object removed from memory

```
1
2     // Point class declaration represents an x-y coordinate pair.
3
4     public class Point {
5        private int x;  // x part of coordinate pair
6        private int y;  // y part of coordinate pair
7
8        // no-argument constructor
9        public Point()
10       {
11          // implicit call to Object constructor occurs here
12          System.out.println( "Point no-argument constructor: " + this );
13       }
14
15       // constructor
16       public Point( int xValue, int yValue )
17       {
18          // implicit call to Object constructor occurs here
19          x = xValue;  // no need for validation
20          y = yValue;  // no need for validation
21
22          System.out.println( "Point constructor: " + this );
23       }
24
25       // finalizer
26       protected void finalize()
27       {
28          System.out.println( "Point finalizer: " + this );
29       }
30
```

Constructor and finalizer output messages to demonstrate method call order.

```
31       // set x in coordinate pair
32       public void setX( int xValue )
33       {
34          x = xValue;  // no need for validation
35       }
36
37       // return x from coordinate pair
38       public int getX()
39       {
40          return x;
41       }
42
43       // set y in coordinate pair
44       public void setY( int yValue )
45       {
46          y = yValue;  // no need for validation
47       }
48
49       // return y from coordinate pair
50       public int getY()
51       {
52          return y;
53       }
54
55       // return String representation of Point4 object
56       public String toString()
57       {
58          return "[" + getX() + ", " + getY() + "]";
59       }
60
61    } // end class Point
```

```java
// Fig. 9.18: Circle.java
// Circle5 class declaration.

public class Circle extends Point {

   private double radius;  // Circle's radius

   // no-argument constructor
   public Circle()
   {
      // implicit call to Point constructor occurs here
      System.out.println( "Circle no-argument constructor: " + this );
   }

   // constructor
   public Circle( int xValue, int yValue, double radiusValue )
   {
      super( xValue, yValue );  // call Point constructor
      setRadius( radiusValue );

      System.out.println( "Circle constructor: " + this );
   }

   // finalizer
   protected void finalize()
   {
      System.out.println( "Circle finalizer: " + this );

      super.finalize();  // call superclass finalize method
   }

```

Constructor and finalizer output messages to demonstrate method call order.

```
// set radius
  public void setRadius( double radiusValue ) {
    radius = ( radiusValue < 0.0 ? 0.0 : radiusValue );  }
 // return radius
 public double getRadius() { return radius; }
  // calculate and return diameter
 public double getDiameter()  { return 2 * getRadius(); }
 // calculate and return circumference
 public double getCircumference() { return Math.PI * getDiameter(); }

 public double getArea()       {
         return Math.PI * getRadius() * getRadius();
      }
        // return String representation of Circle5 object
 public String toString()
      {
         return "Center = " + super.toString() + "; Radius = " +
getRadius();
      }
 } // end class Circle
```

```
1  // Fig. 9.19: ConstructorFinalizerTest.java
2  // Display order in which superclass and subclass
3  // constructors and finalizers are called.
4
5  public class ConstructorFinalizerTest {
6
7     public static void main( String args[] )
8     {
9        Point point;
10       Circle circle1, circle2;
11
12       point = new Point( 11, 22 );
13
14       System.out.println();
15       circle1 = new Circle( 72, 29, 4.5 );
16
17       System.out.println();
18       circle2 = new Circle( 5, 7, 10.67 );
19
20       point = null;    // mark for garbage collection
21       circle1 = null;  // mark for garbage collection
22       circle2 = null;  // mark for garbage collection
23
24       System.out.println();
25
```

`Point` object goes in and out of scope immediately.

Instantiate two `Circle` objects to demonstrate order of subclass and superclass constructor/finalizer method calls.

```
26         System.gc();  // call the garbage collector
27
28      } // end main
29
30   } // end class ConstructorFinalizerTest
```

```
Point constructor: [11, 22]

Point constructor: Center = [72, 29]; Radius = 0.0
Circle constructor: Center = [72, 29]; Radius = 4.5

Point constructor: Center = [5, 7]; Radius = 0.0
Circle constructor: Center = [5, 7]; Radius = 10.67

Point finalizer: [11, 22]
Circle finalizer: Center = [72, 29]; Radius = 4.5
Point finalizer: Center = [72, 29]; Radius = 4.5
Circle finalizer: Center = [5, 7]; Radius = 10.67
Point finalizer: Center = [5, 7]; Radius = 10.67
```

Subclass `Circle` constructor body executes after superclass `Point4`'s constructor finishes execution.

Finalizer for `Circle` object called in reverse order of constructors.