Abstract classes and methods

We give a simple explanation of abstract classes and abstract methods.

Making a class abstract

Consider class Shape and one of its subclasses, Circle, outlined to the right. There would be other subclasses, like Rectangle, and Triangle.

```
/** An instance maintains the position of a
  *  shape in a window. */
public              class Shape {
    private int x;  //shape is at (x,y)
    private int y;
...
}
```

```
/** An instance is a Circle at a position in a
     window. */
public  class Circle extends Shape {
    private double radius;  //shape is at (x,y)

    /** Constructor: Circle at (x, y) radius r */
   public Circle(int x, int y, double r) {
         super(x, y);  radius= r;
   }

   /** = area of this circle */
   public double area() {
          return Math.PI * radius * radius;
   }
...
}
```

Class Shape is there to hold information that is common to all subclasses, like the position of a shape in a GUI window. We don't want users to create instances of class Shape because an instance really isn't a shape; all it holds is the position of shapes.

In order to prevent users from creating instances of class Shape, make Shape *abstract* by putting keyword **abstract** between **public** and **class**:

public abstract class Shape { … }

Doing that makes the expression **new** Shape(…) illegal; if you use it, your program won't compile.

You can still have Shape variables. Example: you can do this:

Shape sp= **new** Circle(5, 10, 2.5);

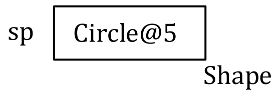
But you *can't* do this:

Shape sp= **new** Shape(5, 10);

Reason for making a class abstract: So you cannot create instances of it; it cannot be "newed".

Making a method abstract

You know the rule in Java that for a variable sp with a Shape perspective, meaning it was declared as a Shape variable, a method call like sp.area() is legal only if it is declared in class Shape or one of its superclasses. Your program won't compile if it has a call



sp.area(5, 6, 2.5)

because method area() is not defined in Shape or in Object. Java has this rule because it wants to be sure that the method exists at runtime. It wouldn't exist at runtime if some subclass of Shape didn't declare area(), and there is no way to guarantee that.

So that we don't have to cast down to a subclass to call method area(), we put the method in class Shape. This method should not be called, since there is no known area in Shape. So we have it throw an exception.

Put this method in class Shape

```
/** = area of this circle */
public double area() {
    throw new
        RunTimeException("why");
}
```

But we still have a problem. Some subclass may not implement method area(). To force all subclasses to implement the method, we make the method abstract, by placing keyword **abstract** after **public** and replacing the method body by a semicolon ";".

Put this method in class Shape

```
/** = area of this circle */
public abstract double area() ;
```

Reason for making a method in an abstract class abstract: So subclasses must implement it.

Note: Some subclass C of Shape could *also* be abstract. If C is abstract, it doesn't have to implement method area() —but subclasses of C would have to implement it.