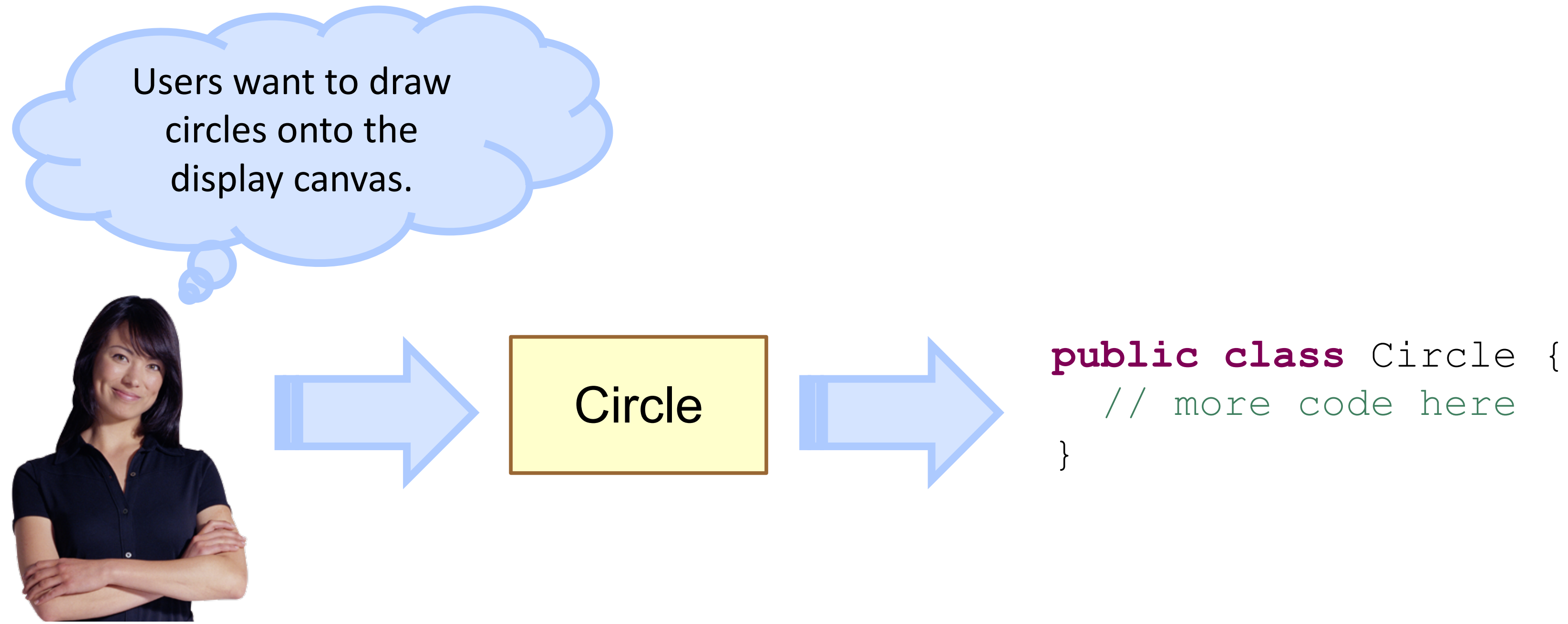
Reviewing OO Concepts



SWEN-261
Introduction to Software Engineering

Department of Software Engineering
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Rochester Institute of Technology

OO Programming is about visualizing a class, modeling the class and then coding the class.

- Programming is and will always be a mental activity.
- UML modeling gives shape to your mental model.
  - *To make your mental model more concrete*
  - *To validate your mental model with stakeholders*
  - *To share with other developers*
- The UML model acts as a guide during development.

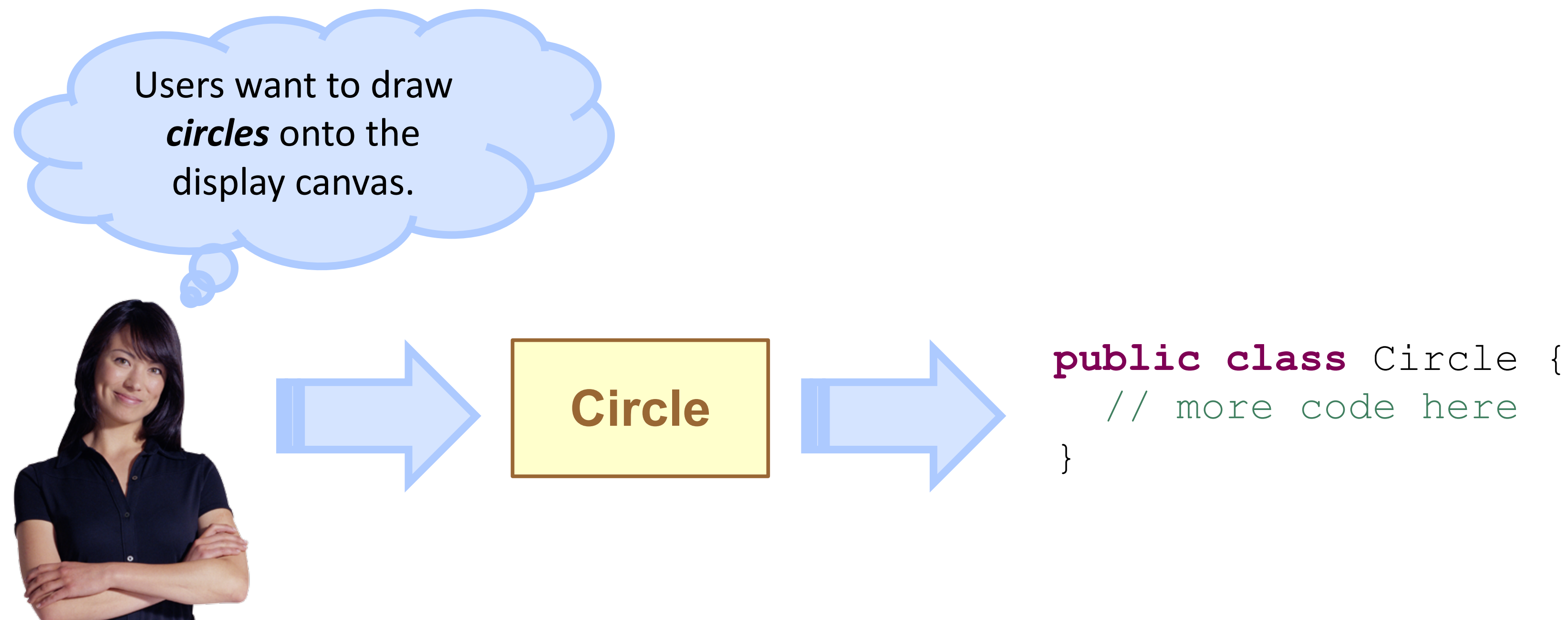
The object-oriented paradigm is based on several basic concepts.

- These include:
  - Object identity
  - Abstraction
  - Encapsulation
  - Information hiding
  - Associations
  - Inheritance
  - Polymorphism

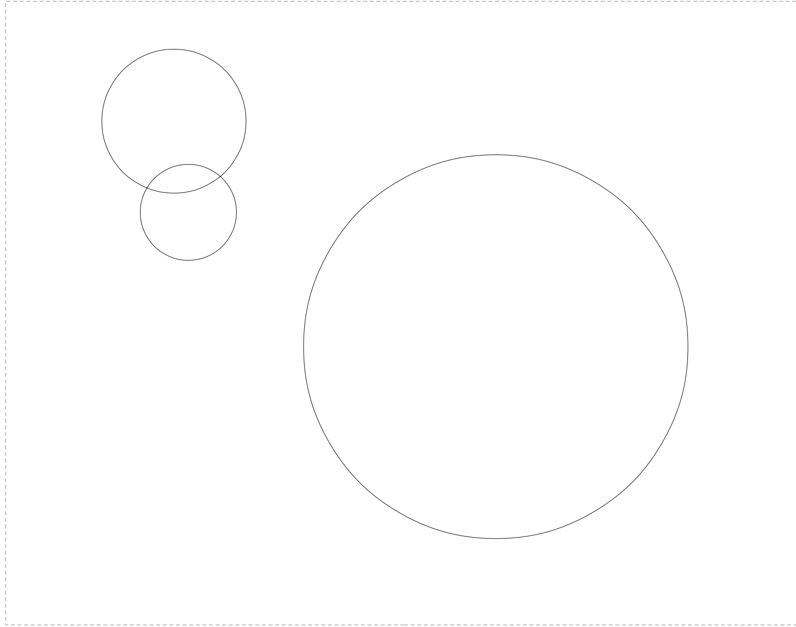
Imagine a drawing application in which the user can place shapes on a canvas. Let's start with a circle.

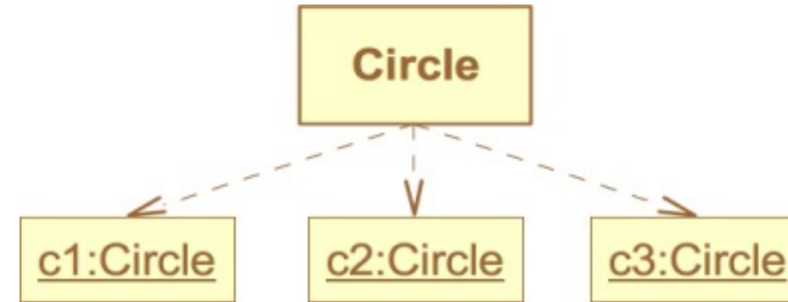
All OO programming starts with classes and objects.

- A *class* is a template for run-time *objects*.
- Use UML class notation to model your mental model of a circle.
- Java classes implement these models.



One class may have many unique objects.





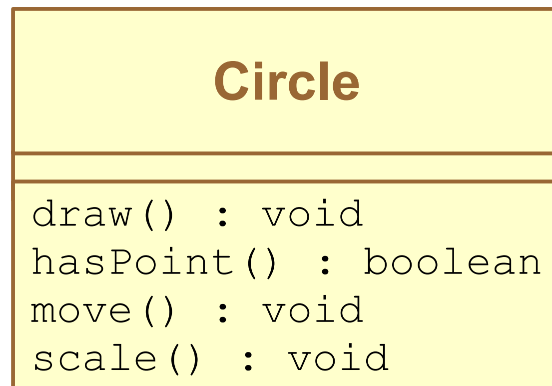

```
public void make_multiple_objects() {
  Circle c1 = new Circle();
  Circle c2 = new Circle();
  Circle c3 = new Circle();
  if (c1 != c2) {
      // Two distinct objects have different identities.
  }
}
```

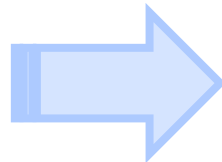
A large part of object-oriented design is about assigning responsibilities to classes.

- Considering a circle, the user will need to:
  - ***Select a circle by clicking on it.***
  - ***Move a circle by dragging it to a new position.***
  - ***Scale the circle by dragging the edge.***
- Of course the set of behaviors is totally dependent upon the domain of the specific application. For example a CAD app also provides:
  - ***Show circumference and area of a circle***
  - ***Align circles and with other shapes to a grid***
  - ***Calculate unions, intersections, and exclusions between circles and other shapes***
- We'll talk about design more fully later but for now let's focus on OO concepts and UML.

Objects perform behaviors defined by their class.

- Look to the verbs to identify behaviors.
- As an artist I also need to:
  - ***Select*** ***a circle by clicking on it.***
  - ***Move*** ***a circle by dragging it to a new position.***
  - ***Scale*** ***the circle by dragging the edge.***
- This starting point forms a sketch of a Java class.

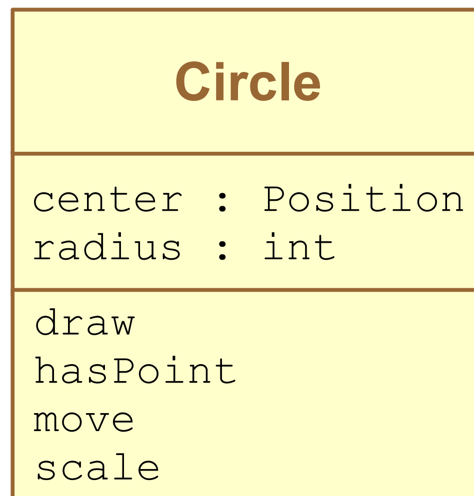


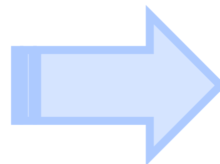


```
public class Circle {
  void draw() { /* TBD */ }
  boolean hasPoint() { /* TBD */ }
  void move() { /* TBD */ }
  void scale() { /* TBD */ }
}
```

Objects use attributes defined in the class while performing behaviors.

- Include the known attributes of an object in the class definition.
- Identify the data types for each attribute.
  - *Might be "primitives" like `int` and `String`*
  - *Or it might be other domain types, like `Position`*
- Keep the attributes hidden using `private`



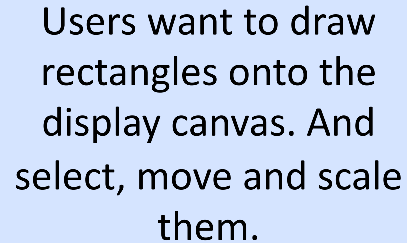


```
public class Circle {
  private Position center;
  private int radius;
  // more code here
}
```

Design the class interface to provide the behaviors that the client needs.

- Getters and setters are not benign!
  - ***Provide them only when absolutely necessary***
- Provide semantically interesting methods
  - ***Don't use setCenter(), rather the circle movesTo() a postion***
- Be particularly careful about exposing the class' data structures like maps, sets, lists, etc.
  - ***Don't provide getters and setters for these***

OK, let's go back to our developer. She now needs to design a `Rectangle` class.



Do you notice any duplication with `Circle`?

Rectangle
-topLeftCorner : Position -width : int -height : int
+move(p:Position) : void +scale(f:float) : void +draw() +hasPoint(p:Position):boolean

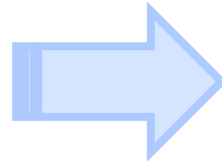
Circle
-center : Position -radius : int
+draw() +hasPoint(p:Position):boolean +move(p:Position) : void +scale(f:float) : void

There's a principle in software development: *Don't repeat yourself.*

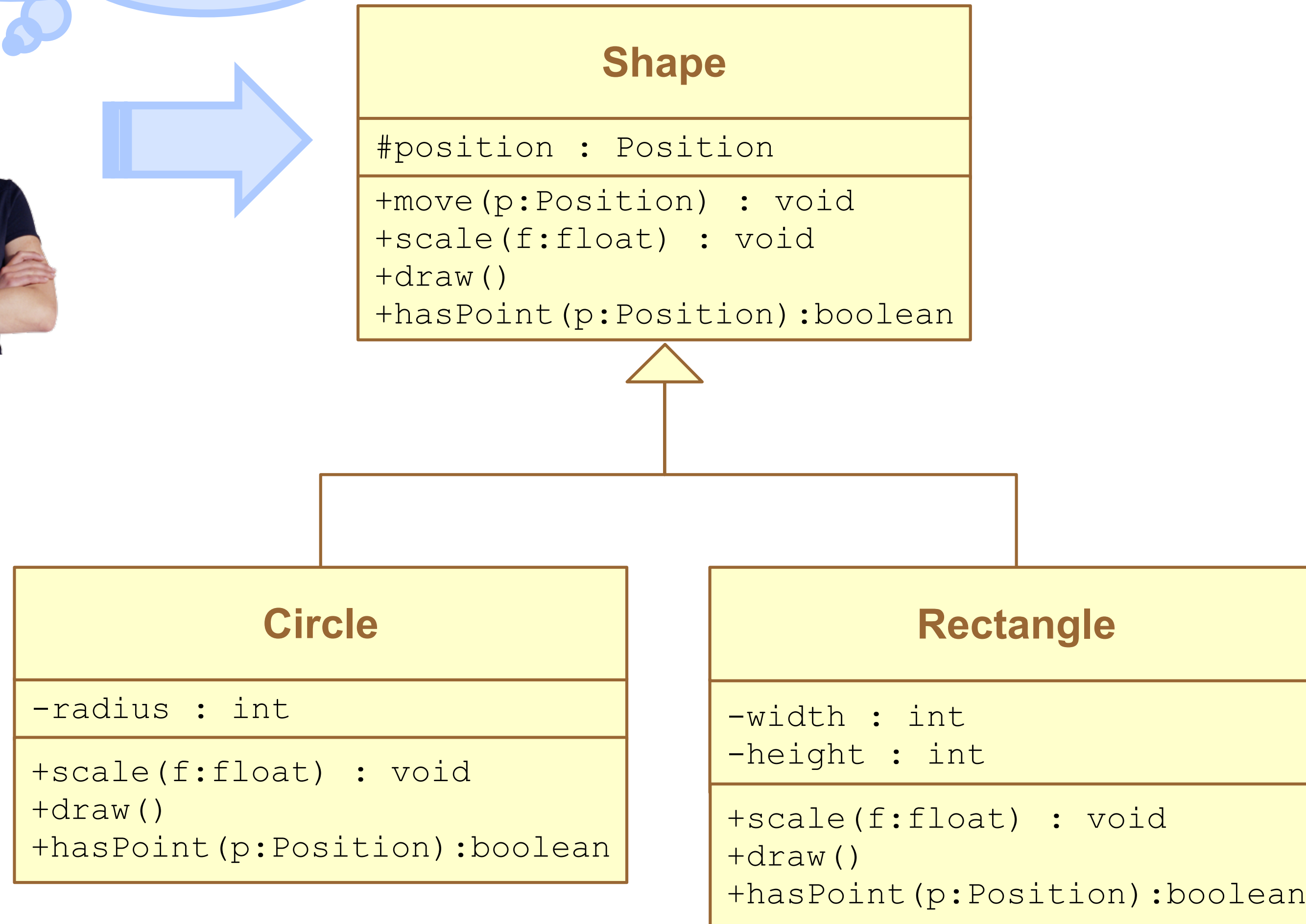
- Both `Circle` and `Rectangle` have a position.
- They have `move` methods and other methods with identical signatures.

- What should you do to not repeat yourself?

Pull shared attributes and behaviors into a super class.



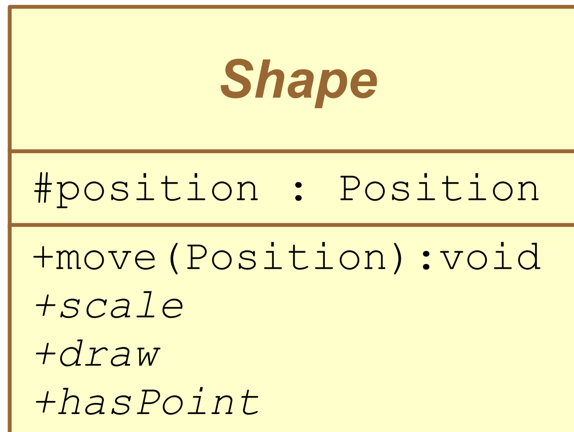
The drawing app now deals
with two kinds of shapes:
circles and rectangles.



Should the super class be abstract?

- Specifically for the drawing app, can you add a "shape" (ie, a generic shape) to the canvas?
  - ***If yes, then it can not be abstract.***
  - ***If no, then restrict the ability to instantiate the `Shape` class by making it abstract.***

Use italics on labels for abstract "things".




```
public abstract class Shape {
  protected Position position;

  protected Shape(final Position position) {
    this.position = position;
  }
  public void move(Position position) {
    this.position = position;
  }
  public abstract void draw();
  // more code not shown
}
```

Make the class abstract.

Make all constructors protected.

Make some methods abstract.

Here's the code for the `Circle` subclass.

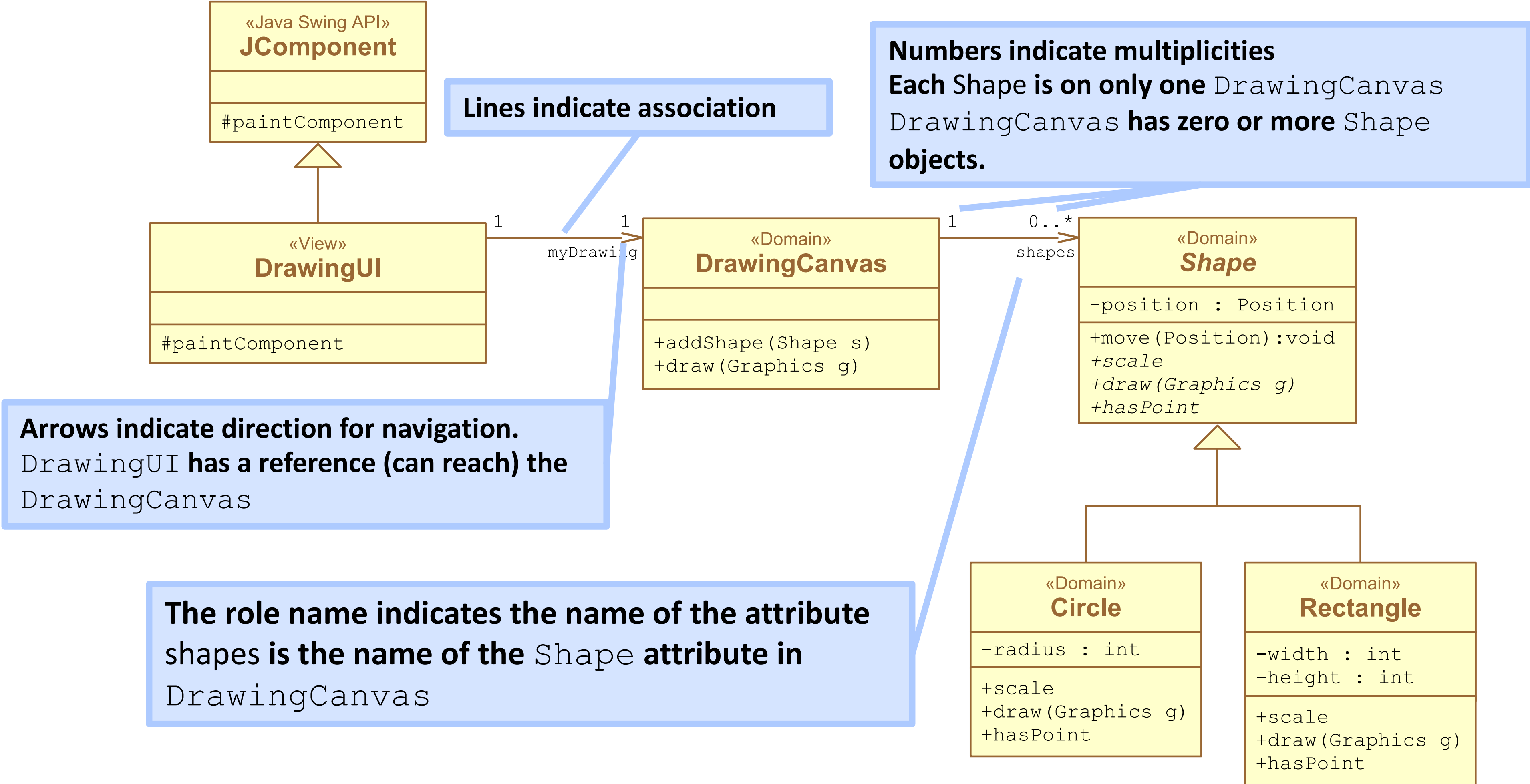
```
public class Circle extends Shape {
  private int radius;

  public Circle(final Position center, final int radius) {
    super(center);
    this.radius = radius;
  }

  public void draw() { /* TBD */ }

  public void scale(float factor) {
    this.radius = (int) (radius * factor);
  }

  public boolean hasPoint(Position p) {
    return p.distanceTo(position) <= radius;
  }
}
```

Use the `extends` keyword to allow the `Circle` class to inherit the attributes and methods of the super class: `Shape`.

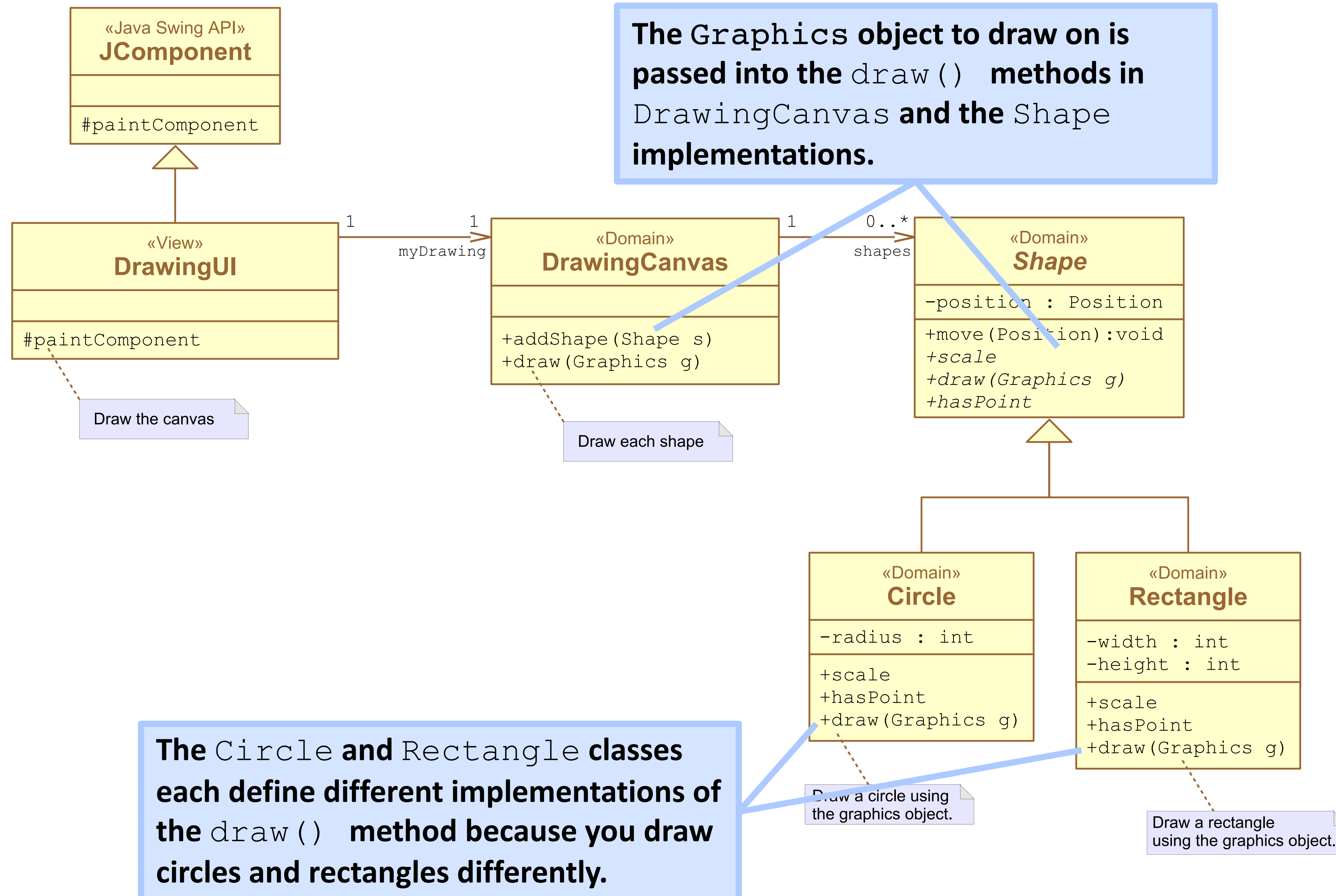
Use the `super` keyword to invoke the `Shape` constructor.

You can use protected members of the `Shape` class.

Our developer has been busy and has created the following Java/Swing application architecture.



This simple system exhibits additional object-oriented programming concepts.



The Graphics object to draw on is passed into the draw() methods in DrawingCanvas and the Shape implementations.

The Circle and Rectangle classes each define different implementations of the draw() method because you draw circles and rectangles differently.

The `DrawingCanvas` class draws a set of shapes.

```
public class DrawingCanvas {
private Set<Shape> shapes = new HashSet<>();

  public void addShape(final Shape s) {
    shapes.add(s);
  }

  public void draw(Graphics g) {
    // Draw each shape
    for (Shape s : shapes) {
      s.draw(g);
    }
  }

}
```

`s` **is defined as a** Shape **object on which the** `draw()` **method is called. How does the** `Circle.draw()` **method get called for circles, and the** `Rectangle.draw()` **method for rectangles?**

The lecture reviewed OO concepts and used defensive programming practices.

OO Concepts Reviewed

- Object identity
- Encapsulation
- Information hiding
- Inheritance
- Abstraction
- Associations
- Polymorphism

Defensive programming

- Private/protected attributes and methods
- Final attributes and parameters
- Minimized use of getters and setters
- Hide internal data structures