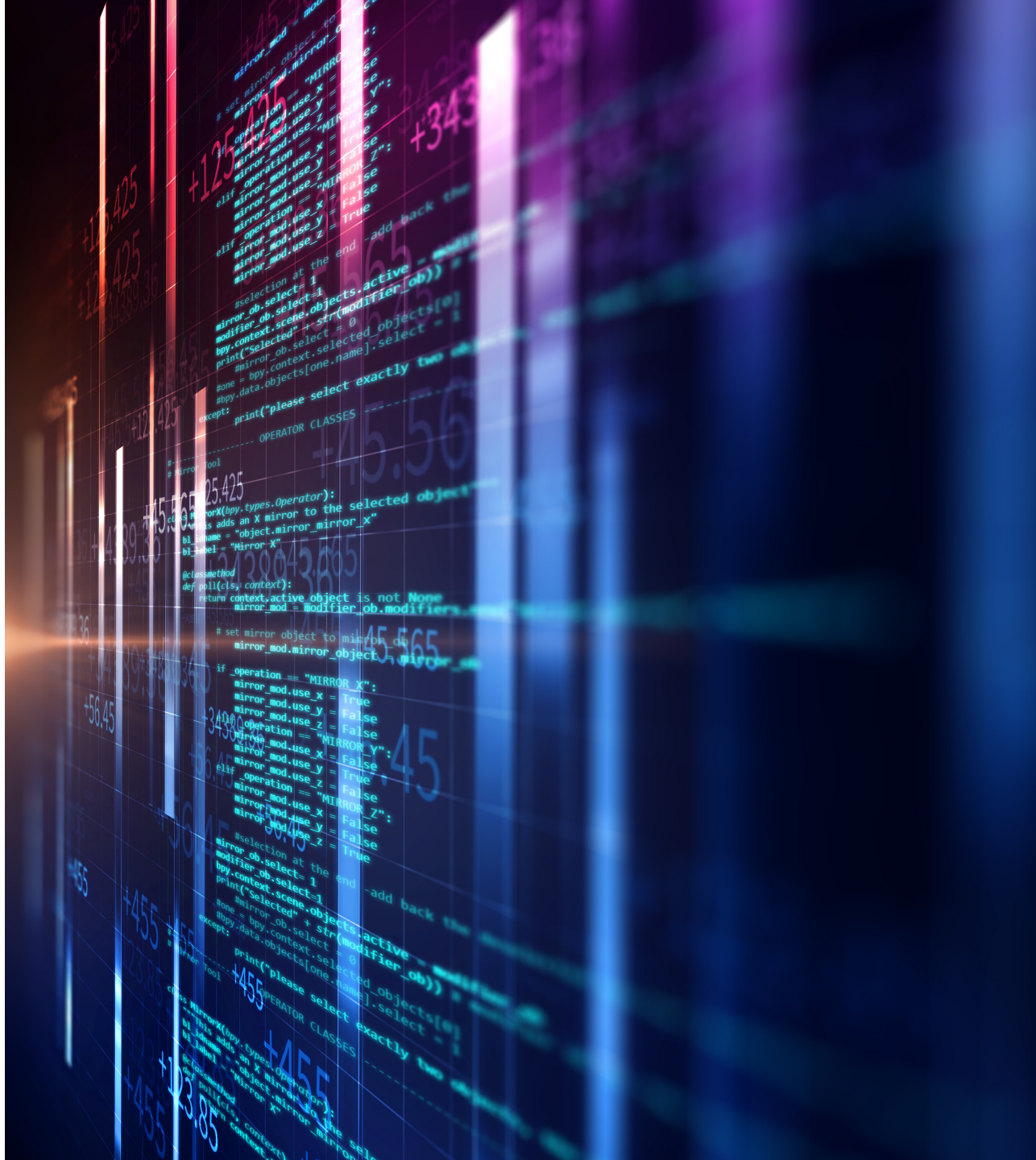
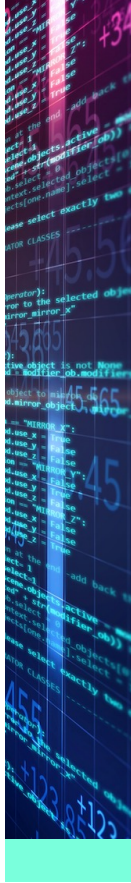
Interfaces

Brandon Krakowsky

Penn Engineering

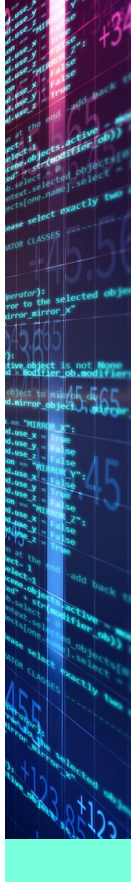


Interfaces



Interfaces

- An interface declares (describes) methods but does not supply bodies for them
  - An interface is a *pure* abstract class -- *none* of its methods are defined



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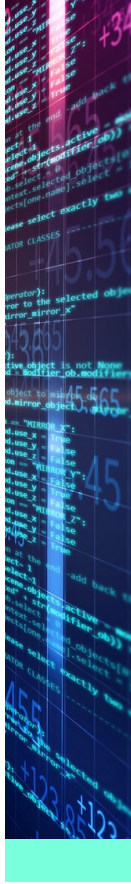

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```
public interface KeyListener {
    void keyPressed(KeyEvent e); //declares method keyPressed
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}
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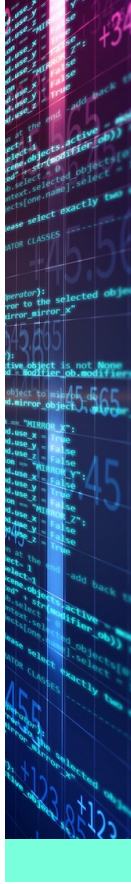

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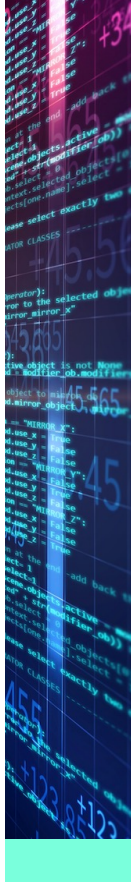
  - You can add these qualifiers if you like, but why bother?



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}
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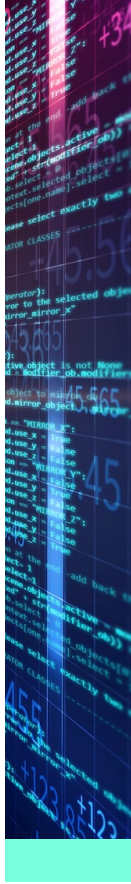
- All the methods are implicitly public and abstract
  - You can add these qualifiers if you like, but why bother?
- Like an abstract class, you CANNOT instantiate an interface

```
KeyListener keyListener = new KeyListener(); //You CANNOT do this
```



Common Interfaces

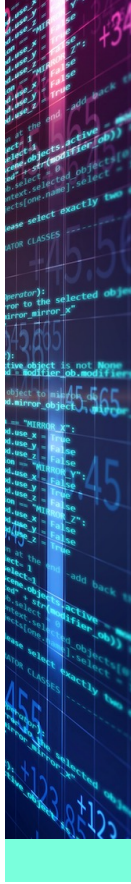
- You will sometimes use the supplied Java interfaces
- For example

  KeyListener: Interface for receiving keyboard events (keystrokes). Classes interested in processing keyboard events will implement this interface (and all the methods it contains).

  Iterable: Implementing this interface allows an object to be the target of a *for loop* statement. (Like an ArrayList)

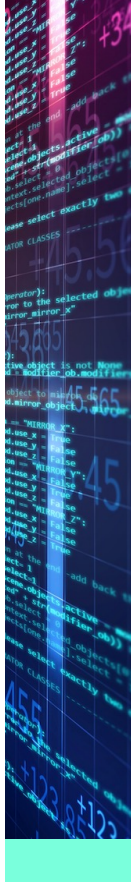
  Comparable: For objects interested in being compared and conforming to order.

  Etc. …



Designing Interfaces

- Sometimes you'll want to design your own interface



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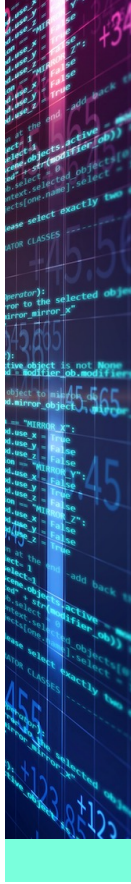
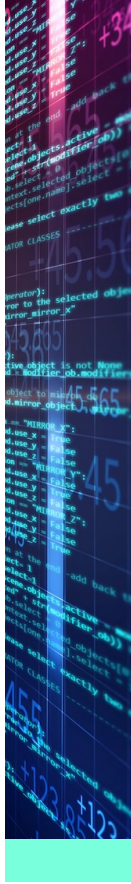
- You would write an interface if you want classes of various types to all have a certain set of capabilities



Designing Interfaces

- Sometimes you'll want to design your own interface
- You would write an interface if you want classes of various types to all have a certain set of capabilities
- For example, if you want to be able to create different kinds of vehicles, you might define an interface Driveable:

```
public interface Driveable {
    void turnLeft(double angle);
    void turnRight(double angle);
    void reverse();
    void accelerate(int increment);
    void decelerate(int decrement);
}
```



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```
public interface Driveable {
    void turnLeft(double angle);
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    void reverse();
    void accelerate(int increment);
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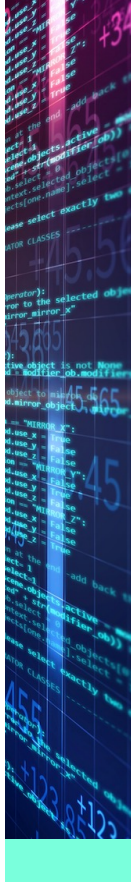
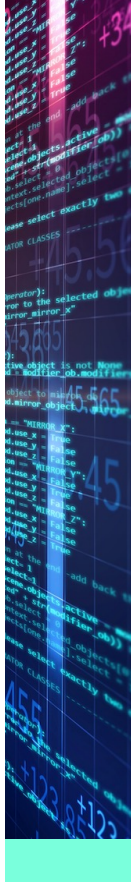
}
```

- Now you can create any kind of vehicle with these capabilities by implementing Driveable



Implementing an Interface I

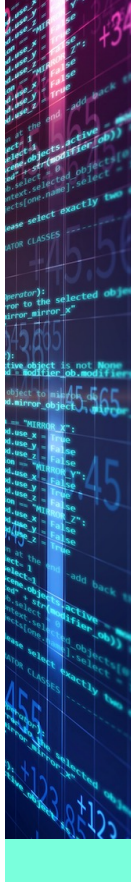
- You extend a class, but you implement an interface



Implementing an Interface I

- You extend a class, but you implement an interface
- A class can only extend (subclass) one other class, but it can implement as many interfaces as you like

```
public class MyListener implements KeyListener, ActionListener {
    …
}
```



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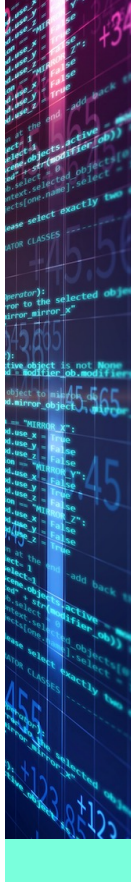
- A class can only extend (subclass) one other class, but it can implement as many interfaces as you like

```
public class MyListener implements KeyListener, ActionListener {
    …
}
```

- A class can extend another class AND implement interfaces

```
public class MyClass extends AnotherClass implements KeyListener,
ActionListener {
    …
}
```



Implementing an Interface II

- When you say a class implements an interface, you are promising to define all the methods that are declared in the interface

```
public class MyKeyListener implements KeyListener {
      public void keyPressed(KeyEvent e) {...}
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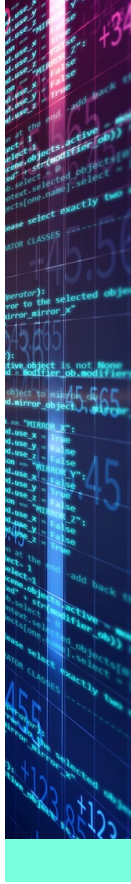
      public void keyTyped(KeyEvent e) {...}
}
```



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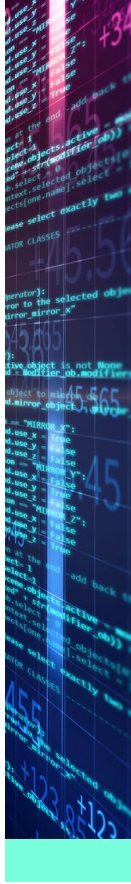
- The "…" indicates actual code (the method bodies) that you must supply



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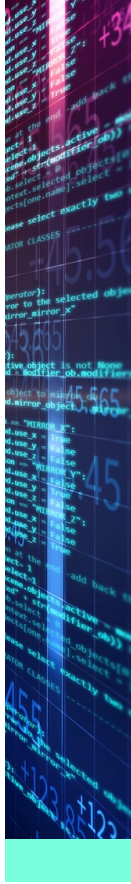
}
```

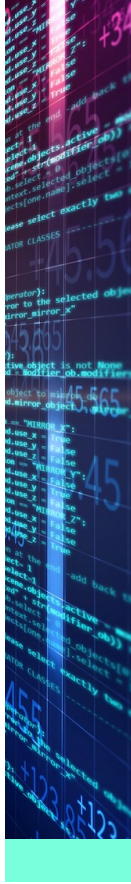
- The "…" indicates actual code (the method bodies) that you must supply
- Now you can create a new MyKeyListener

```
MyKeyListener myKeyListener = new MyKeyListener();
```



Partially Implementing an Interface

- What if you only care about *some* of the methods declared in an interface?



Partially Implementing an Interface

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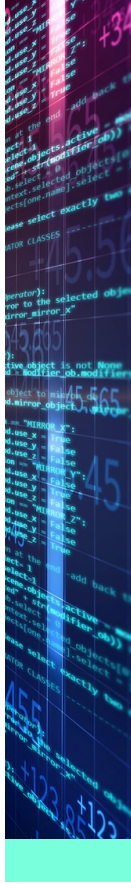

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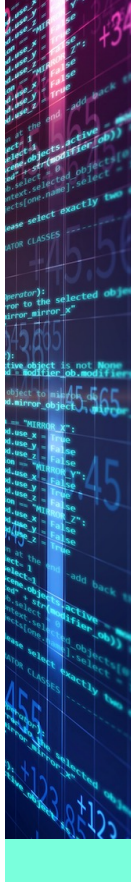
- What if you only care about *some* of the methods declared in an interface?
- It's possible for a class to define some, but not all of the methods
- To do this, a class *must* be defined as abstract

```
public abstract class MyKeyListener implements KeyListener {
    public void keyTyped(KeyEvent e) {...};
}
```

  - MyKeyListener is *only* implementing keyTyped
  - Thus, MyKeyListener must be defined as abstract



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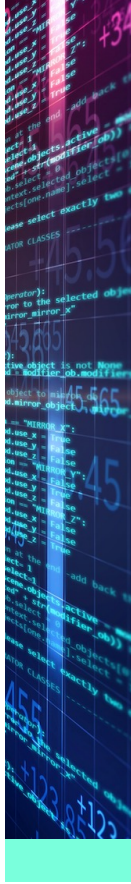
public abstract class MyKeyListener implements KeyListener {
    public void keyTyped(KeyEvent e) {...};
}
```

  - MyKeyListener is *only* implementing keyTyped
  - Thus, MyKeyListener must be defined as abstract
- You can even extend an interface (to add additional methods)

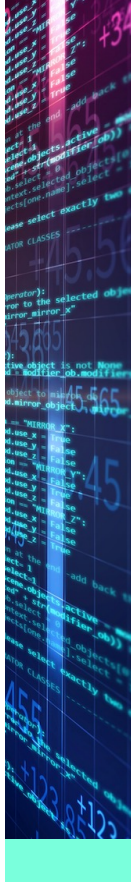
```
public interface MyFunkyKeyListener extends KeyListener { ... }
```



What Are Interfaces For?

Reason 1: A class can only extend one other class, but it can implement multiple interfaces

- This allows classes to fill multiple “roles”



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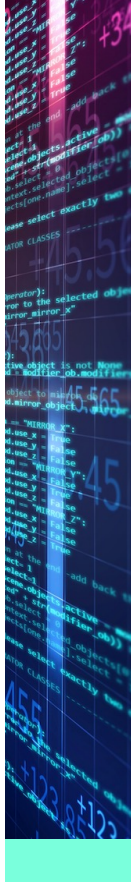
- This allows classes to fill multiple “roles”
- For example, in writing user interfaces, it’s common to have a class be able to handle different kinds of user interactions
  - Button clicks
  - Keyboard events
  - Mouse wheel rotations
  - Etc …

```
public class MyUserInterface extends Applet implements
ActionListener, KeyListener  {
        ...
}
```

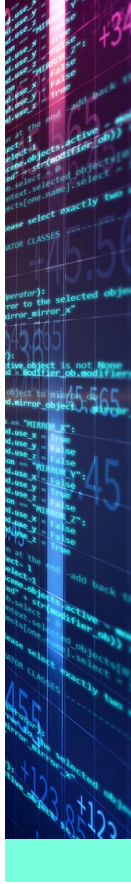


What Are Interfaces For?

Reason 2: You can write methods that work for more than one kind of class

- Here's an interface for different kinds of board games

```
public interface RuleSet {
    boolean isLegal(Move m, Board b);
    void makeMove(Move m);
}
```



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- Here's an interface for different kinds of board games

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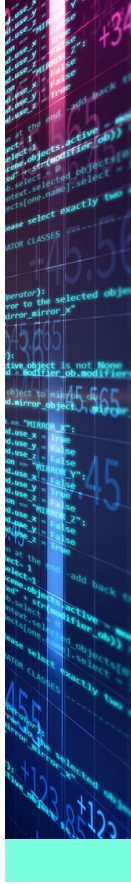
public interface RuleSet {
    boolean isLegal(Move m, Board b);
    void makeMove(Move m);
}
```

- Every class that implements RuleSet must have these methods

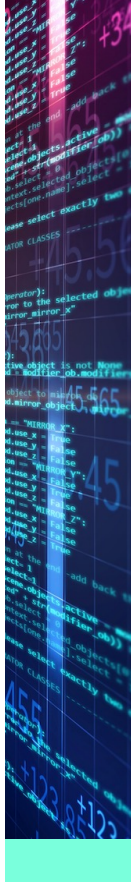
```
public class CheckersRules implements RuleSet {
    public boolean isLegal(Move m, Board b) { ... } //implemented
method
    public void makeMove(Move m) { ... } //implemented method
}
```



How to Use an Interface

- Here's another implementation of RuleSet

```
public class ChessRules implements RuleSet {
    public boolean isLegal(Move m, Board b) { ... } //implemented method
    public void makeMove(Move m) { ... } //implemented method
}
```



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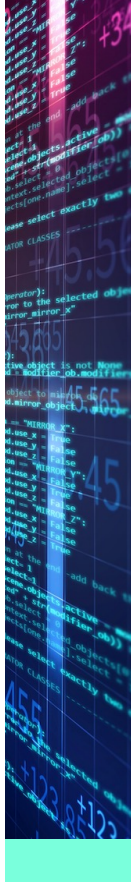
    public boolean isLegal(Move m, Board b) { ... } //implemented method
    public void makeMove(Move m) { ... } //implemented method
}
```

- And here, an abstract class, is implementing RuleSet

```
public abstract class LinesOfActionRules implements RuleSet {
    public void makeMove(Move m) { … } //implemented method
    public void makeHorizontalMoveOneSpace() { … } //another concrete method
}
```

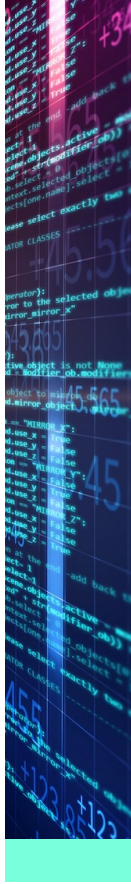
  - LinesOfActionRules is implementing one method, *makeMove*, from RuleSet
  - It also has another concrete method *makeHorizontalMoveOneSpace*
  - Thus, LinesOfActionRules must be defined as abstract



How to Use an Interface

```
RuleSet rulesOfThisGame = new ChessRules();
```

- This assignment IS LEGAL because a rulesOfThisGame object is a RuleSet object



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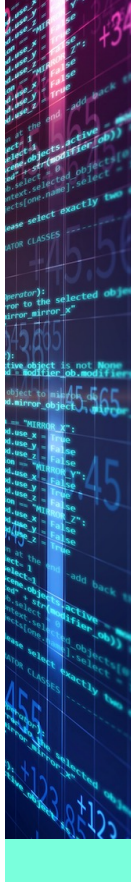
```
if (rulesOfThisGame.isLegal(m, b)) {
        rulesOfThisGame.makeMove(m);
   }
```

- This statement IS LEGAL because, whatever kind of RuleSet object rulesOfThisGame is, it must have isLegal and makeMove methods



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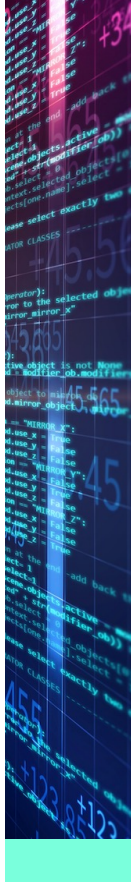
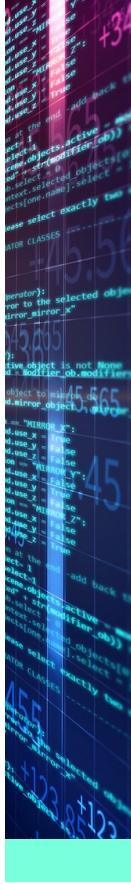
```
RuleSet rulesOfThisGameTwo = new LinesOfActionRules();
```

- This statement IS ILLEGAL because LinesOfActionRules is an abstract class, by default, because it didn't implement all methods of RuleSet



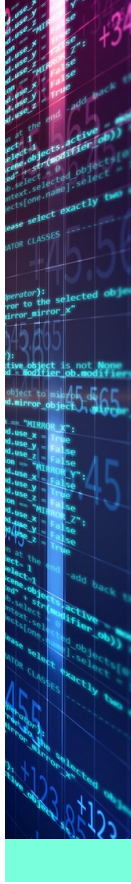
Shape Interface Project



Shape Interface

Shape.java

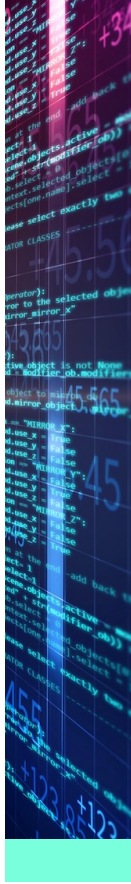
```java
/**
 * Interface for shapes.
 * @author brandonkrakowsky
 *
 */
public interface Shape {

    /**
     * Returns area of shape.
     * @return area
     */
    public double area();

    /**
     * Returns perimeter of shape.
     * @return perimeter
     */
    public double perimeter();

    /**
     * Draws shape.
     */
    public void draw();
```



Circle Class

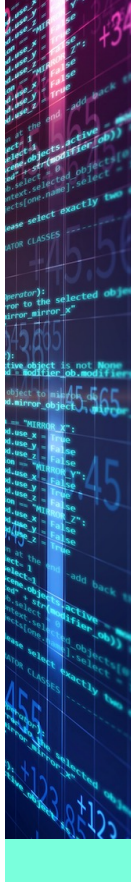
Shape.java | Circle.java

```java
/**
 * Represents a circle.
 * Implements Shape.
 * @author brandonkrakowsky
 *
 */
public class Circle implements Shape {

    private static final double PI = Math.PI;

    /**
     * Radius of circle.
     */
    private double radius;

    /**
     * Creates a circle with given radius.
     * @param radius of circle
     */
    public Circle(double radius){
        this.radius = radius;
    }
```



Circle Class

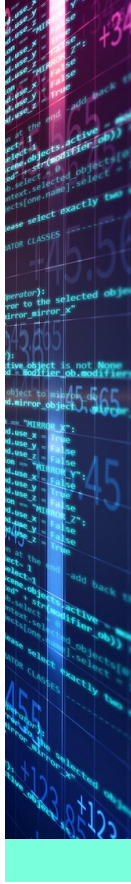
```
24      /**
25       * Returns area of circle.
26       */
27      @Override
28      public double area() {
29          return Circle.PI * this.radius * this.radius;
30      }
31
32      /**
33       * Returns perimeter of circle.
34       */
35      @Override
36      public double perimeter() {
37          return 2 * Circle.PI * this.radius;
38      }
39
40      /**
41       * Draws this circle.
42       */
43      @Override
44      public void draw() {
45          System.out.println("Drawing a circle with radius " + this.radius);
46      }
47
```



Cube Interface

Shape.java | Circle.java | Cube.java

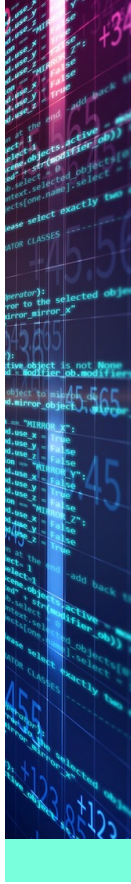
```
1  /**
2   * Interface for cubes.
3   * @author brandonkrakowsky
4   *
5   */
6  public interface Cube {
7
8      /**
9       * Returns volume of cube.
10      * @return volume
11      */
12     public double volume();
13 }
14
```



Square Class

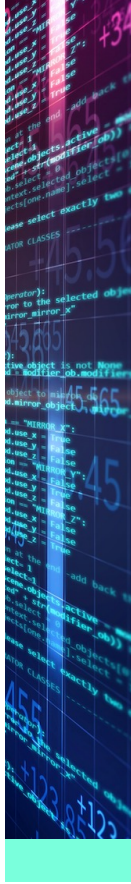
Shape.java | Circle.java | Cube.java | Square.java

```java
/**
 * Represents a Square.
 * Implements Shape and Cube.
 * @author brandonkrakowsky
 *
 */
public class Square implements Shape, Cube {

    /**
     * Length of single side of square.
     */
    private double sideLength;

    /**
     * Creates square with given side length.
     * @param sideLength of square
     */
    public Square(double sideLength){
        this.sideLength = sideLength;
    }

```



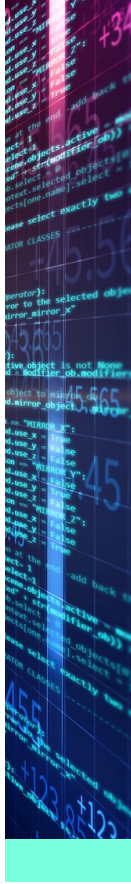
Square Class

```
21
22      /**
23       * Returns area of square.
24       */
25      @Override
26      public double area(){
27          return this.sideLength * this.sideLength;
28      }
29
30      /**
31       * Returns perimeter of square.
32       */
33      @Override
34      public double perimeter(){
35          return 4 * this.sideLength;
36      }
37
38      /**
39       * Draws this square.
40       */
41      @Override
42      public void draw(){
43          System.out.println("Drawing a square with side length " + this.sideLength);
44      }
```



Square Class

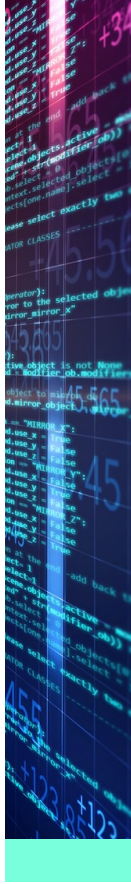
```
45
46      /**
47       * Returns volume of cube made up of squares.
48       */
49      @Override
50      public double volume() {
51          return Math.pow(this.sideLength, 3);
52      }
```



Triangle Abstract Class

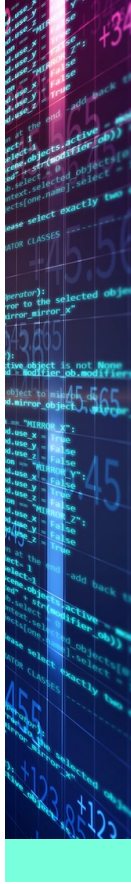
Shape.java | Circle.java | Cube.java | Square.java | Triangle.java

```java
/**
 * Abstract class representing a triangle.
 * Implements Shape.
 * @author brandonkrakowsky
 *
 */
public abstract class Triangle implements Shape {

    /**
     * Sides of triangle.
     */
    protected double sideA, sideB, sideC;

    /**
     * Creates triangle with given sides.
     * @param sideA for triangle
     * @param sideB for triangle
     * @param sideC for triangle
     */
    public Triangle(double sideA, double sideB, double sideC){
        this.sideA = sideA;
        this.sideB = sideB;
        this.sideC = sideC;
    }
```



Triangle Abstract Class

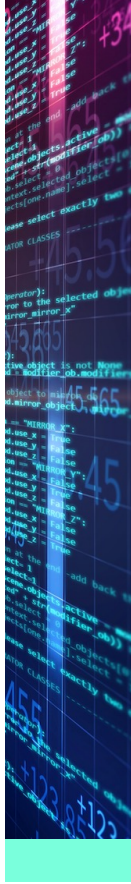
```
26      /**
27       * Returns the perimeter of triangle.
28       */
29      @Override
30      public double perimeter() {
31          return this.sideA + this.sideB + this.sideC;
32      }
33
34      /**
35       * Draws this triangle.
36       */
37      @Override
38      public void draw() {
39          System.out.println("Drawing a triangle with length of sides "
40                  + this.sideA + ", "
41                  + this.sideB + ", "
42                  + this.sideC);
43      }
```



Right Triangle Class

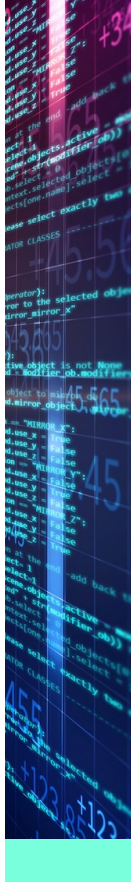
Circle.java | Cube.java | Square.java | Triangle.java | RightTriangle.j

```java
/**
 * Represents a right triangle.
 * Extends Triangle.
 * @author brandonkrakowsky
 *
 */
public class RightTriangle extends Triangle {

    /**
     * Creates Right Triangle with given sides.
     * @param sideA for triangle
     * @param sideB for triangle
     */
    public RightTriangle(double sideA, double sideB){
        super(sideA, sideB, RightTriangle.getHypotenuse(sideA, sideB));
    }
```



Right Triangle Class

```
18      /**
19       * Returns area of right triangle.
20       */
21      @Override
22      public double area() {
23          return (this.sideA * this.sideB) / 2;
24      }
25
26      //static method: does not require instance of RightTriangle to call
27      //call using class name: RightTriangle.getHypotenuse(a, b);
28      /**
29       * Returns the hypotenuse of right triangle based on given side a and b.
30       * @param side a of triangle
31       * @param side b of triangle
32       * @return hypotenuse
33       */
34      private static double getHypotenuse(double a, double b){
35          return Math.sqrt((a * a) + (b * b));
36      }
37
```



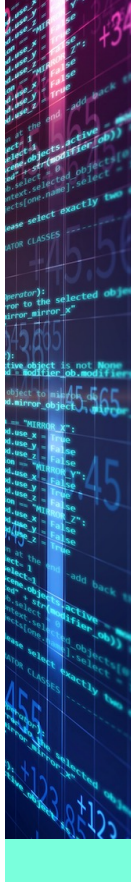
Equilateral Triangle Class

Circle.java | Cube.java | Square.java | Triangle.java | RightTriangle.j | EquilateralTria

```java
/**
 * Represents an equilateral triangle.
 * Extends Triangle.
 * @author brandonkrakowsky
 *
 */
public class EquilateralTriangle extends Triangle {

    /**
     * Creates equilateral triangle with given side length.
     * @param sideLength of equilateral triangle
     */
    public EquilateralTriangle(double sideLength){
        super(sideLength, sideLength, sideLength);
    }

```

Equilateral Triangle Class

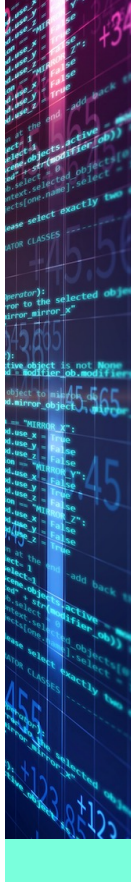
```
17      /**
18       * Returns area of equilateral triangle.
19       */
20      @Override
21      public double area() {
22          return (Math.sqrt(3) / 4) * (this.sideA * this.sideA);
23      }
24
```



Shape Class

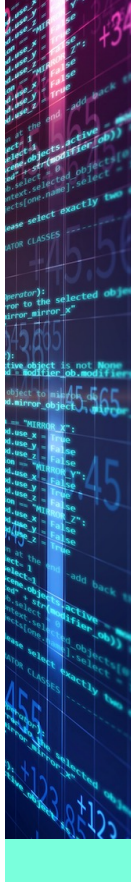
Shape.java

```
25
26      public static void main(String[] args) {
27
28          System.out.println("Circle");
29
30          //create circle with radius
31          Circle circle = new Circle(4);
32
33          //call implemented methods in interface shape
34          System.out.println(circle.area());
35          System.out.println(circle.perimeter());
36          circle.draw();
37
```



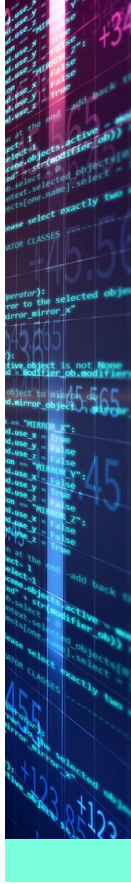
Shape Class

```
38
39          System.out.println("");
40          System.out.println("Square");
41
42          //create square with size of side
43          Square square = new Square(4);
44
45          //call implemented methods in interface shape
46          System.out.println(square.area());
47          System.out.println(square.perimeter());
48          square.draw();
49
50          //call implemented methods in interface cube
51          System.out.println(square.volume());
52
```



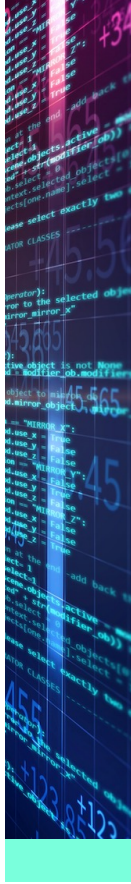
Shape Class

```
53
54          System.out.println("");
55          System.out.println("Triangles");
56
57          //create right triangle with size of two sides
58          RightTriangle rightTriangle = new RightTriangle(3, 5);
59
60          //call implemented methods in right triangle
61          System.out.println(rightTriangle.area());
62
63          //call implemented methods in triangle
64          System.out.println(rightTriangle.perimeter());
65          rightTriangle.draw();
66
```



Shape Class

```
66
67          System.out.println("");
68
69          //create equilateral triangle with size of one side
70          EquilateralTriangle equalateralTriangle = new EquilateralTriangle(3);
71
72          //call implemented method in equilateral triangle
73          System.out.println(equalateralTriangle.area());
74
75      }
```



Shape Class

```
76
77          System.out.println("");
78          System.out.println("Iterate over arraylist of shapes and call common methods implemented in each.");
79
80          //arraylist of shapes
81          ArrayList<Shape> shapes = new ArrayList<Shape>();
82          shapes.add(circle);
83          shapes.add(square);
84          shapes.add(rightTriangle);
85          shapes.add(equilateralTriangle);
86
87          //iterate over arraylist of shapes and call common methods implemented in each
88          for (Shape s : shapes) {
89              System.out.println(s.area());
90              System.out.println(s.perimeter());
91              s.draw();
92              System.out.println("");
93          }
94      }
```