

# CSE 11

# Accelerated Intro to Programming

## Lecture 8

Greg Miranda, Summer 2 2021

This lecture is being recorded

# Announcements

- PA3 due today @ 11:59pm
- PA4 released today, due Sunday @ 11:59pm
- Lecture Quiz #3 due tomorrow @ 11:59pm
- Lecture Quiz #4 due Sunday @ 11:59pm
- PA0.5 and PA1 resubmissions due tomorrow @ 11:59pm
- Exam 1 – Friday, August 20<sup>th</sup>
  - More details next week (and on Piazza)

```
class CircleRegion {  
    ...  
    boolean contains(Point p)  
    { ... }  
}
```

```
class SquareRegion {  
    ...  
    boolean contains(Point p)  
    { ... }  
}
```

Both classes have a method with the **same header**

We can write an **interface** with the shared method

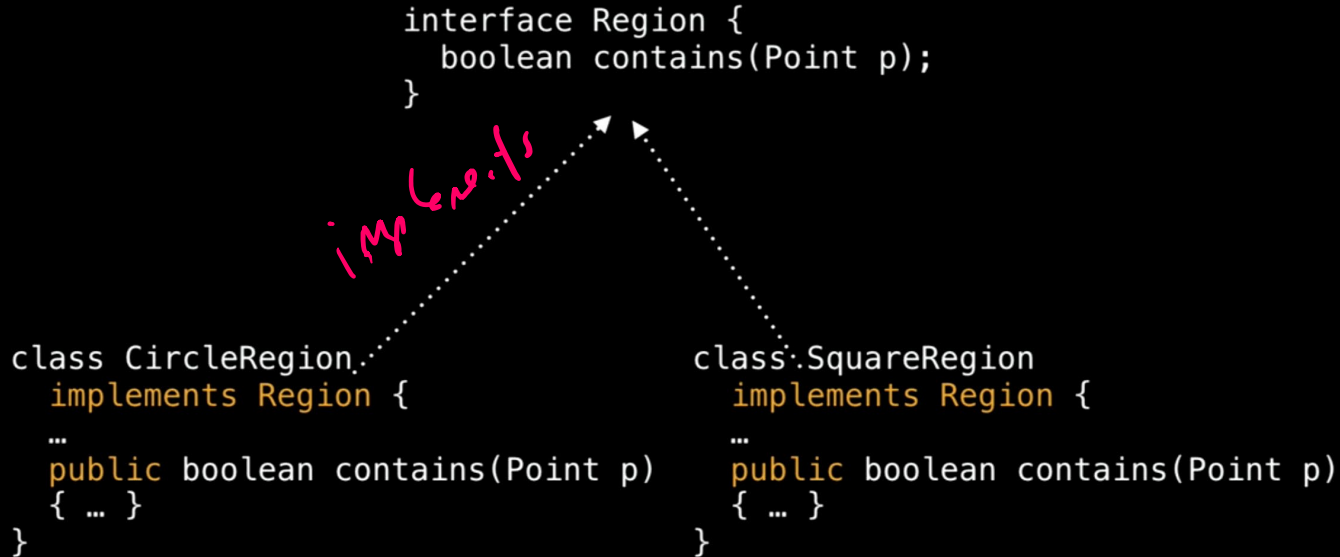
*new type* [ interface Region {  
    boolean contains(Point p);  
}

```
class CircleRegion
    implements Region {
    ...
    public boolean contains(Point p)
    { ... }
}
```

```
class SquareRegion
    implements Region {
    ...
    public boolean contains(Point p)
    { ... }
}
```

Both classes have a method with the **same header**

We can write an **interface** with the shared method



Both classes have a method with the **same header**

```
interface Region {  
    boolean contains(Point p);  
}
```

```
class CircleRegion  
    implements Region {  
    ...  
    public boolean contains(Point p)  
    { ... }  
}
```

```
class SquareRegion  
    implements Region {  
    ...  
    public boolean contains(Point p)  
    { ... }  
}
```

```
class ExamplesRegion {  
    Region circ = new CircleRegion(new Point(10, 5), 4));  
    Region square = new SquareRegion(new Point(5, 6), 8));  
}
```

We can use the same  
**interface type**  
for references of classes that implement it

```
interface Region {  
    boolean contains(Point p);  
}
```

```
class CircleRegion  
    implements Region {  
    Point center;  
    int radius  
    public boolean contains(Point p)  
    { ... }  
}
```

```
class SquareRegion  
    implements Region {  
    Point center;  
    int sideLength;  
    public boolean contains(Point p)  
    { ... }  
}
```

```
class ExamplesRegion {  
    Region circ = new CircleRegion(new Point(10, 5), 4));  
    Region square = new SquareRegion(new Point(5, 6), 8));  
    int num = circ.radius;  
}
```

What is stored in  
the num field?

A: 10    C: 5

1 B: 8    2 D: it's an error

10 E: something else

```
interface Region {  
    boolean contains(Point p);  
}
```

```
class CircleRegion  
    implements Region {  
    Point center;  
    int radius  
    public boolean contains(Point p)  
    { ... }  
}
```

```
class SquareRegion  
    implements Region {  
    Point center;  
    int sideLength;  
    public boolean contains(Point p)  
    { ... }  
}
```

```
class ExamplesRegion {  
    Region circ = new CircleRegion(new Point(10, 5), 4);  
    Region square = new SquareRegion(new Point(5, 6), 8);  
    boolean contains1 = circ.contains(new Point(7, 6));  
}
```

What is stored in  
the contains1 field?

§ A: true | ~~C: error~~  
4 B: false



```
interface Region {  
    boolean contains(Point p);  
}
```

```
class CircleRegion  
    implements Region {  
    ...  
    public boolean contains(Point p)  
    { ... }  
}
```

```
class SquareRegion  
    implements Region {  
    ...  
    public boolean contains(Point p)  
    { ... }  
}
```

```
class UnionRegion {  
    Region r1, r2;  
    UnionRegion(Region r1, Region r2) { ... }  
    public boolean contains(Point p) {  
        return this.r1.contains(p) ||  
               this.r2.contains(p);  
    }  
}
```

```

        interface Region {
            boolean contains(Point p);
        }

class CircleRegion
    implements Region {
    ...
    public boolean contains(Point p)
    { ... }
}

class SquareRegion
    implements Region {
    ...
    public boolean contains(Point p)
    { ... }
}

```

```

class UnionRegion {
    Region r1, r2;
    UnionRegion(Region r1, Region r2) { ... }
    public boolean contains(Point p) {
        return this.r1.contains(p) ||
               this.r2.contains(p);
    }
}

```

```

class ExamplesRegion {
    Region circ = new CircleRegion(new Point(10, 5), 4);
    Region square = new SquareRegion(new Point(5, 6), 8);
    UnionRegion ur = new UnionRegion(this.square, this.circ);
    boolean b1 = this.ur.contains(new Point(13, 5));
}

```

What is the value of  
the b1 field?

7 A: true / C: error  
2 B: false

# Using Interfaces

- Add Region interface
- Update RectRegion & CircRegion

# Intersect Region

```
interface Region {  
    boolean contains(Point p);  
}
```

```
class IntersectRegion implements Region {  
    Region r1;  
    Region r2;  
    IntersectRegion(Region r1, Region r2) {  
        this.r1 = r1;  
        this.r2 = r2;  
    }  
    public boolean contains(Point p) {  
        return this.r1.contains(p) && this.r2.contains(p);  
    }  
}
```

```
class IntersectRegion implements Region {
```

```
...
```

```
public boolean contains(Point p) {
```

```
    return this.r1.contains(p) && this.r2.contains(p);
```

```
}
```

```
}
```

```
class ExamplesRegion {
```

```
    Region circ1 = new CircleRegion(new Point(10, 5), 4.0);
```

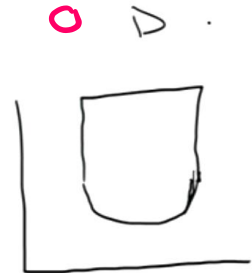
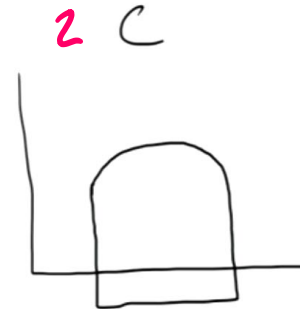
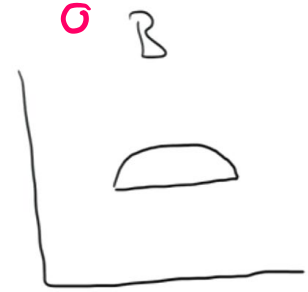
```
    Region sq = new SquareRegion(new Point(10, 1), 8.);
```

```
    Region ir = new IntersectRegion(this.circ1, this.sq);
```

```
//What region is represented in toDraw?
```

```
Region toDraw = ir;
```

```
}
```

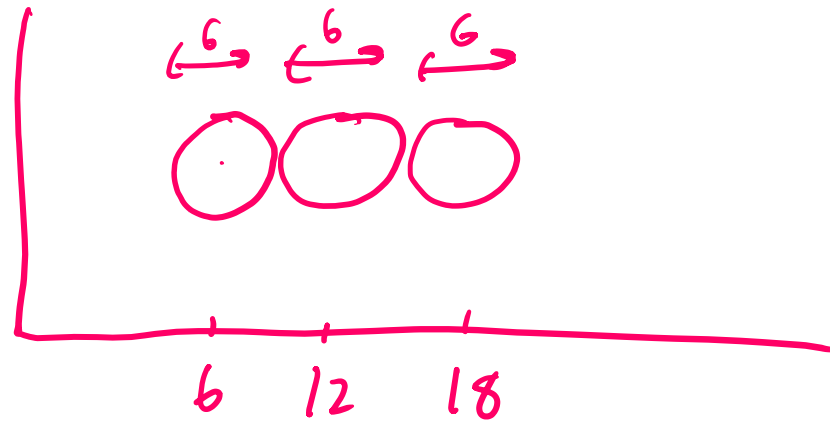


# SubtractRegion

- Write a new class called SubtractRegion
  - That also implements Region
- Represents all the points in region1 that aren't in region2
  - Start with a shape and subtract another shape from it
    - Subtract a circle from another circle to create a ring
- Write the class
  - Fields and constructor
  - What does the contains method look like?

# Something more complicated

- What if we wanted a region that was 3 circles next to each other:
- How could we construct an example of this?



Union of 3 regions

# Inheritance

- New terms
  - abstract class
  - extends



# Abstract Class Summary

- Why did we introduce abstract classes?
  - Multiple classes had the exact same method
    - Same method header (same types)
    - Same implementation
  - add() method – put into all the region classes
    - Same implementation in all of them
    - Made an abstract class
      - Had one implementation of that method
      - Used extends so that all of the implementations could share that one method

```

    private double x, y;
    Point(double x, double y) { this.x = x; this.y = y; }
    double distance(Point other) {
        return Math.sqrt(
            Math.pow(this.x - other.x, 2) +
            Math.pow(this.y - other.y, 2));
    }
    double xDistance(Point other) { return Math.abs(other.x - this.x); }
    double yDistance(Point other) { return Math.abs(other.y - this.y); }
}

interface Region {
    boolean contains(Point p);
    Region add(Region other);
    Region overlap(Region other);
}

abstract class ARegion implements Region {
    public Region add(Region other) {
        return new UnionRegion(this, other);
    }
    public Region overlap(Region other) {
        return new IntersectRegion(this, other);
    }
}

class UnionRegion extends ARegion {
    Region region1, region2;
    UnionRegion(Region region1, Region region2) {
        this.region1 = region1;
        this.region2 = region2;
    }
    public boolean contains(Point toCheck) {
        return this.region1.contains(toCheck) ||
            this.region2.contains(toCheck);
    }
}

class IntersectRegion extends ARegion {
    Region region1, region2;
    IntersectRegion(Region region1, Region region2) {
        this.region1 = region1;
        this.region2 = region2;
    }
    public boolean contains(Point toCheck) {
        return this.region1.contains(toCheck) &&
            this.region2.contains(toCheck);
    }
}

class SubtractRegion implements Region {
    Region region1;
    Region region2;
    SubtractRegion(Region region1, Region region2) {
        this.region1 = region1;
        this.region2 = region2;
    }
    public boolean contains(Point toCheck) {
        return this.region1.contains(toCheck) &&
            !this.region2.contains(toCheck);
    }
}

class SquareRegion extends ARegion {
    Point center;
    double sideLength;
    SquareRegion(Point center, double sideLength) {
        this.center = center;
        this.sideLength = sideLength;
    }
    public boolean contains(Point toCheck) {
        return this.center.xDistance(toCheck) <= (this.sideLength / 2) &&
            this.center.yDistance(toCheck) <= (this.sideLength / 2);
    }
}

class CircleRegion extends ARegion {
    Point center;
    double radius;
    CircleRegion(Point center, double radius) {
        this.center = center;
        this.radius = radius;
    }
    public boolean contains(Point toCheck) {
        return this.center.distance(toCheck) <= this.radius;
    }
}

class ExamplesARegion {
    Region circ1 = new CircleRegion(new Point(10, 5), 4.0);
    Region sq = new SquareRegion(new Point(10, 1), 8.0);
    Region ir = this.circ1.add(this.sq);
}

```

```

    private double x, y;
    Point(double x, double y) { this.x = x; this.y = y; }
    double distance(Point other) {
        return Math.sqrt(
            Math.pow(this.x - other.x, 2) +
            Math.pow(this.y - other.y, 2));
    }
    double xDistance(Point other) { return Math.abs(other.x - this.x); }
    double yDistance(Point other) { return Math.abs(other.y - this.y); }
}

interface Region {
    boolean contains(Point p);
    Region add(Region other);
    Region overlap(Region other);
}

abstract class ARegion implements Region {
    public Region add(Region other) {
        return new UnionRegion(this, other);
    }
    public Region overlap(Region other) {
        return new IntersectRegion(this, other);
    }
}

class UnionRegion extends ARegion {
    Region region1, region2;
    UnionRegion(Region region1, Region region2) {
        this.region1 = region1;
        this.region2 = region2;
    }
    public boolean contains(Point toCheck) {
        return this.region1.contains(toCheck) ||
            this.region2.contains(toCheck);
    }
}

class IntersectRegion extends ARegion {
    Region region1, region2;
    IntersectRegion(Region region1, Region region2) {
        this.region1 = region1;
        this.region2 = region2;
    }
    public boolean contains(Point toCheck) {
        return this.region1.contains(toCheck) &&
            this.region2.contains(toCheck);
    }
}

class SubtractRegion implements Region {
    Region region1;
    Region region2;
    SubtractRegion(Region region1, Region region2) {
        this.region1 = region1;
        this.region2 = region2;
    }
    public boolean contains(Point toCheck) {
        return this.region1.contains(toCheck) &&
            !this.region2.contains(toCheck);
    }
}

class SquareRegion extends ARegion {
    Point center;
    double sideLength;
    SquareRegion(Point center, double sideLength) {
        this.center = center;
        this.sideLength = sideLength;
    }
    public boolean contains(Point toCheck) {
        return this.center.xDistance(toCheck) <= (this.sideLength / 2) &&
            this.center.yDistance(toCheck) <= (this.sideLength / 2);
    }
}

class CircleRegion extends ARegion {
    Point center;
    double radius;
    CircleRegion(Point center, double radius) {
        this.center = center;
        this.radius = radius;
    }
    public boolean contains(Point toCheck) {
        return this.center.distance(toCheck) <= this.radius;
    }
}

class ExamplesARegion {
    Region circ1 = new CircleRegion(new Point(10, 5), 4.0);
    Region sq = new SquareRegion(new Point(10, 1), 8.0);
    Region ir = this.circ1.add(this.sq);
}

```

```

    private double x, y;
    Point(double x, double y) { this.x = x; this.y = y; }
    double distance(Point other) {
        return Math.sqrt(
            Math.pow(this.x - other.x, 2) +
            Math.pow(this.y - other.y, 2));
    }
    double xDistance(Point other) { return Math.abs(other.x - this.x); }
    double yDistance(Point other) { return Math.abs(other.y - this.y); }
}

interface Region {
    boolean contains(Point p);
    Region add(Region other);
    Region overlap(Region other);
}

abstract class ARegion implements Region {
    public Region add(Region other) {
        return new UnionRegion(this, other);
    }
    public Region overlap(Region other) {
        return new IntersectRegion(this, other);
    }
}

class UnionRegion extends ARegion {
    Region region1, region2;
    UnionRegion(Region region1, Region region2) {
        this.region1 = region1;
        this.region2 = region2;
    }
    public boolean contains(Point toCheck) {
        return this.region1.contains(toCheck) ||
            this.region2.contains(toCheck);
    }
}

class IntersectRegion extends ARegion {
    Region region1, region2;
    IntersectRegion(Region region1, Region region2) {
        this.region1 = region1;
        this.region2 = region2;
    }
    public boolean contains(Point toCheck) {
        return this.region1.contains(toCheck) &&
            this.region2.contains(toCheck);
    }
}

class SubtractRegion implements Region {
    Region region1;
    Region region2;
    SubtractRegion(Region region1, Region region2) {
        this.region1 = region1;
        this.region2 = region2;
    }
    public boolean contains(Point toCheck) {
        return this.region1.contains(toCheck) &&
            !this.region2.contains(toCheck);
    }
}

class SquareRegion extends ARegion {
    Point center;
    double sideLength;
    SquareRegion(Point center, double sideLength) {
        this.center = center;
        this.sideLength = sideLength;
    }
    public boolean contains(Point toCheck) {
        return this.center.xDistance(toCheck) <= (this.sideLength / 2) &&
            this.center.yDistance(toCheck) <= (this.sideLength / 2);
    }
}

class CircleRegion extends ARegion {
    Point center;
    double radius;
    CircleRegion(Point center, double radius) {
        this.center = center;
        this.radius = radius;
    }
    public boolean contains(Point toCheck) {
        return this.center.distance(toCheck) <= this.radius;
    }
}

class ExamplesARegion {
    Region circ1 = new CircleRegion(new Point(10, 5), 4.0);
    Region sq = new SquareRegion(new Point(10, 1), 8.0);
    Region ir = this.circ1.add(this.sq);
}

```

```

class UnionRegion extends ARegion {
    Region r1, r2;
    UnionRegion(Region r1, Region r2) {
        this.r1 = r1;
        this.r2 = r2;
    }
    public boolean contains(Point p) {
        return this.r1.contains(p) &&
            this.r2.contains(p);
    }
}

```

```

class IntersectRegion extends ARegion {
    Region r1, r2;
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        this.r1 = r1;
        this.r2 = r2;
    }
    public boolean contains(Point p) {
        return this.r1.contains(p) &&
            this.r2.contains(p);
    }
}

```

```

private double x, y;
Point(double x, double y) { this.x = x; this.y = y; }
double distance(Point other) {
    return Math.sqrt(
        Math.pow(this.x - other.x, 2) +
        Math.pow(this.y - other.y, 2));
}
double xDistance(Point other) { return Math.abs(other.x - this.x); }
double yDistance(Point other) { return Math.abs(other.y - this.y); }

interface Region {
    boolean contains(Point p);
    Region addRegion(Region other);
    Region overlap(Region other);
}

abstract class ARegion implements Region {
    public Region addRegion(Region other) {
        return new UnionRegion(this, other);
    }
    public Region overlap(Region other) {
        return new IntersectRegion(this, other);
    }
}

class UnionRegion extends ARegion {
    Region region1, region2;
    UnionRegion(Region region1, Region region2) {
        this.region1 = region1;
        this.region2 = region2;
    }
    public boolean contains(Point toCheck) {
        return this.region1.contains(toCheck) ||
            this.region2.contains(toCheck);
    }
}

class IntersectRegion extends ARegion {
    Region region1, region2;
    IntersectRegion(Region region1, Region region2) {
        this.region1 = region1;
        this.region2 = region2;
    }
    public boolean contains(Point toCheck) {
        return this.region1.contains(toCheck) &&
            this.region2.contains(toCheck);
    }
}

class SubtractRegion implements Region {
    Region region1;
    Region region2;
    SubtractRegion(Region region1, Region region2) {
        this.region1 = region1;
        this.region2 = region2;
    }
    public boolean contains(Point toCheck) {
        return this.region1.contains(toCheck) &&
            !this.region2.contains(toCheck);
    }
}

class SquareRegion extends ARegion {
    Point center;
    double sideLength;
    SquareRegion(Point center, double sideLength) {
        this.center = center;
        this.sideLength = sideLength;
    }
    public boolean contains(Point toCheck) {
        return this.center.xDistance(toCheck) <= (this.sideLength / 2) &&
            this.center.yDistance(toCheck) <= (this.sideLength / 2);
    }
}

class CircleRegion extends ARegion {
    Point center;
    double radius;
    CircleRegion(Point center, double radius) {
        this.center = center;
        this.radius = radius;
    }
    public boolean contains(Point toCheck) {
        return this.center.distance(toCheck) <= this.radius;
    }
}

class ExamplesARegion {
    Region circ1 = new CircleRegion(new Point(10, 5), 4.0);
    Region sq = new SquareRegion(new Point(10, 1), 4.0);
    Region ir = this.circ1.add(this.sq);
}

```

class UnionRegion extends ARegion {

Region r1, r2;

UnionRegion(Region r1, Region r2) {

this.r1 = r1;

this.r2 = r2;

}

public boolean contains(Point p) {

return this.r1.contains(p) &&

this.r2.contains(p);

}

class IntersectRegion extends ARegion {

Region r1, r2;

IntersectRegion(Region r1, Region r2) {

this.r1 = r1;

this.r2 = r2;

}

public boolean contains(Point p) {

return this.r1.contains(p) ||

this.r2.contains(p);

}

```
class UnionRegion extends ARegion {
```

```
    public boolean contains(Point p) {  
        return this.r1.contains(p) &&  
            this.r2.contains(p);  
    }  
}
```

```
abstract class AComboRegion {  
    Region r1, r2;  
    AComboRegion(Region r1, Region r2) {  
        this.r1 = r1;  
        this.r2 = r2;  
    }  
}
```

```
class IntersectRection extends ARegion
```

```
    public boolean contains(Point p) {  
        return this.r1.contains(p) ||  
            this.r2.contains(p);  
    }  
}
```

```
abstract class AComboRegion extends ARegion {
    Region r1, r2;
    AComboRegion(Region r1, Region r2) {
        this.r1 = r1;
        this.r2 = r2;
    }
}
```

```
class UnionRegion {
```

```
    public boolean contains(Point p) {
        return this.r1.contains(p) &&
            this.r2.contains(p);
    }
}
```

```
class IntersectRection
```

```
    public boolean contains(Point p) {
        return this.r1.contains(p) ||
            this.r2.contains(p);
    }
}
```

```
class UnionRegion extends AComboRegion {
```

```
    public boolean contains(Point p) {  
        return this.r1.contains(p) &&  
            this.r2.contains(p);  
    }  
}
```

```
abstract class AComboRegion extends ARegion {  
    Region r1, r2;  
    AComboRegion(Region r1, Region r2) {  
        this.r1 = r1;  
        this.r2 = r2;  
    }  
}
```

```
class IntersectRection extends AComboRegion
```

```
    public boolean contains(Point p) {  
        return this.r1.contains(p) ||  
            this.r2.contains(p);  
    }  
}
```



```
abstract class AComboRegion extends ARegion {
    Region r1, r2;
    AComboRegion(Region r1, Region r2) {
        this.r1 = r1;
        this.r2 = r2;
    }
}
```

```
class UnionRegion extends AComboRegion {

    UnionRegion(Region r1, Region r2) {
        super(r1, r2);
    }
    public boolean contains(Point p) {
        return this.r1.contains(p) &&
            this.r2.contains(p);
    }
}
```

```
class IntersectRection extends AComboRegion

    IntersectRegion(Region r1, Region r2) {
        super(r1, r2);
    }
    public boolean contains(Point p) {
        return this.r1.contains(p) ||
            this.r2.contains(p);
    }
}
```

```
interface Region { ... }
abstract class ARegion implements Region { ... }
class SquareRegion extends ARegion { ... }
class CircleRegion extends ARegion { ... }

abstract class AComboRegion extends ARegion {
    Region r1, r2;
    AComboRegion(Region r1, Region r2) {
        this.r1 = r1;
        this.r2 = r2;
    }
}

class UnionRegion extends AComboRegion {
    UnionRegion(Region r1, Region r2) {
        super(r1, r2);
    }
    public boolean contains(Point p) {
        return this.r1.contains(p) &&
            this.r2.contains(p);
    }
}

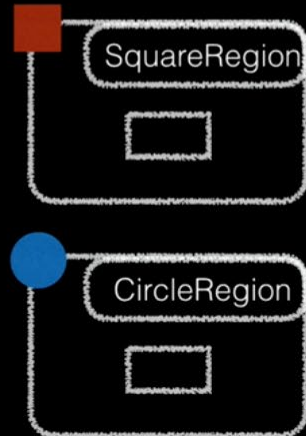
class ExamplesRegion {
    Region sq = new SquareRegion(new Point(4, 5), 8);
    Region ci = new CircleRegion(new Point(6, 7), 10);
    Region ur = new UnionRegion(this.sq, this.ci);
}
```

```
interface Region { ... }
abstract class ARegion implements Region { ... }
class SquareRegion extends ARegion { ... }
class CircleRegion extends ARegion { ... }

abstract class AComboRegion extends ARegion {
    Region r1, r2;
    AComboRegion(Region r1, Region r2) {
        this.r1 = r1;
        this.r2 = r2;
    }
}

class UnionRegion extends AComboRegion {
    UnionRegion(Region r1, Region r2) {
        super(r1, r2);
    }
    public boolean contains(Point p) {
        return this.r1.contains(p) &&
            this.r2.contains(p);
    }
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class ExamplesRegion {
-   Region sq = new SquareRegion(new Point(4, 5), 8);
    Region ci = new CircleRegion(new Point(6, 7), 10);
    Region ur = new UnionRegion(this.sq, this.ci);
}
```



```

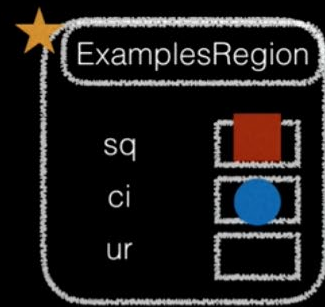
interface Region { ... }
abstract class ARegion implements Region { ... }
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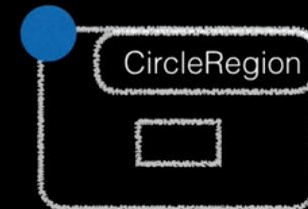
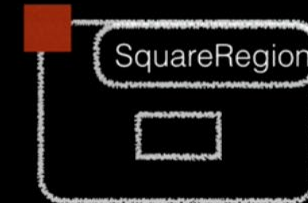
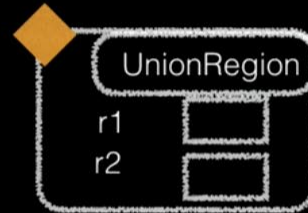
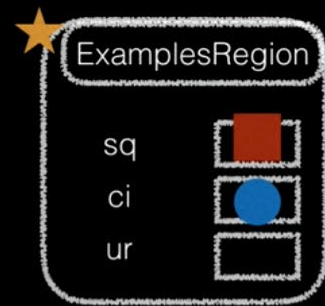
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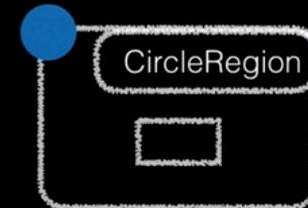
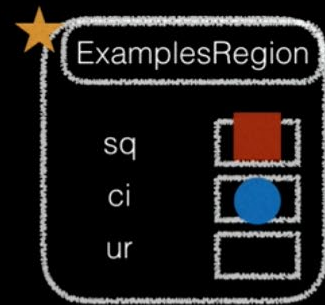
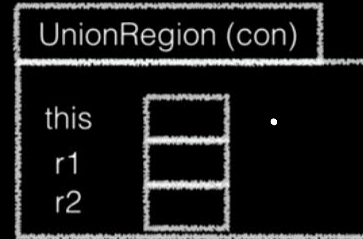
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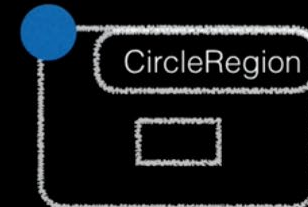
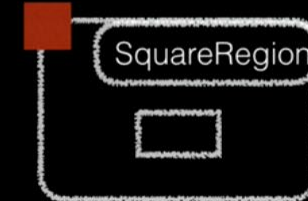
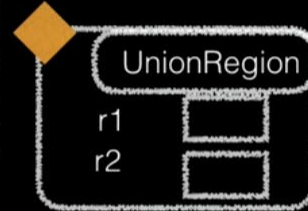
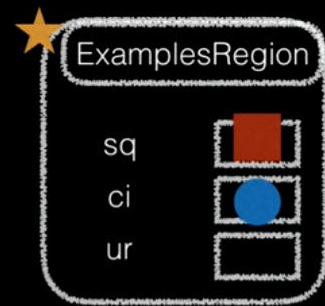
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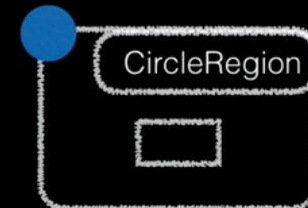
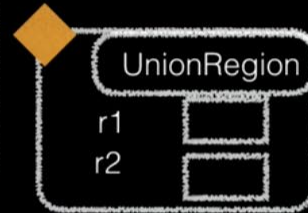
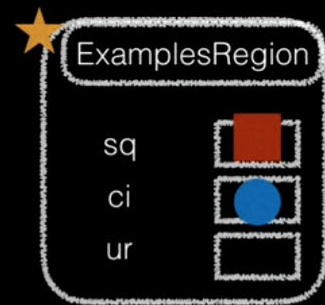
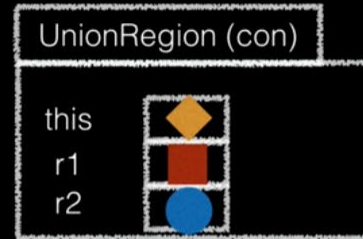
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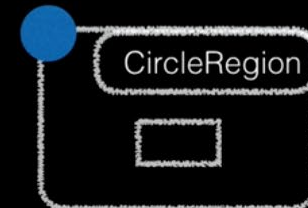
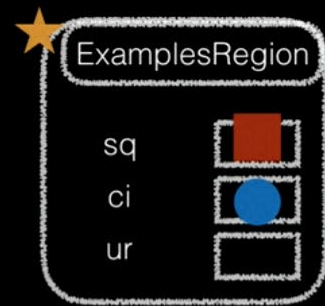
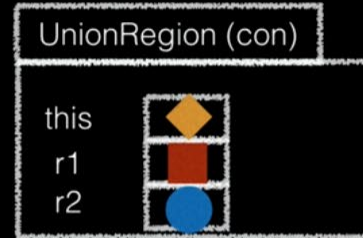
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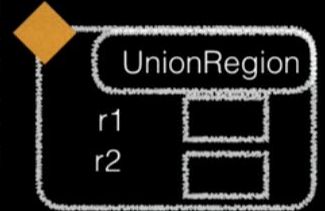
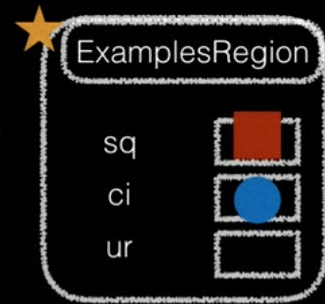
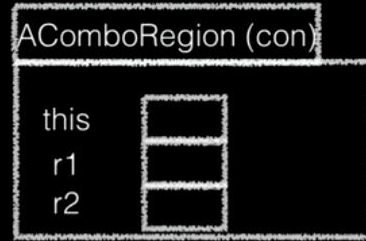
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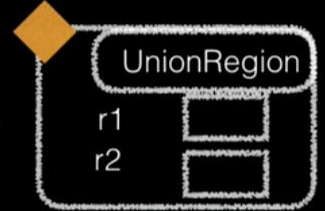
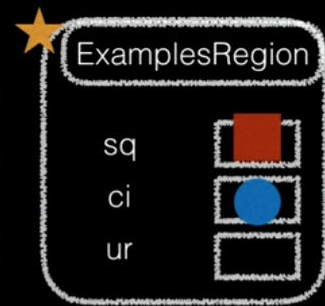
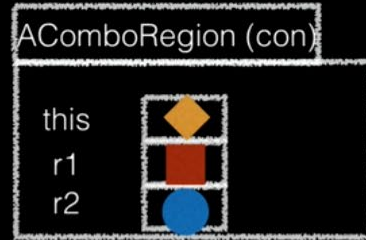
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