CSE 11
Accelerated Intro to Programming
Lecture 7

Greg Miranda, Summer 1 2021

This lecture is being recorded

Announcements

- PA3 due tonight @ 11:59pm
- PA4 due Sunday @ 11:59pm
- PA0.5 and PA1 resubmissions due tomorrow @ 11:59pm
- Quiz 3 due tomorrow @ 11:59pm
- Make-up Lecture tomorrow – same time, same zoom link

100%

```
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

method headers

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

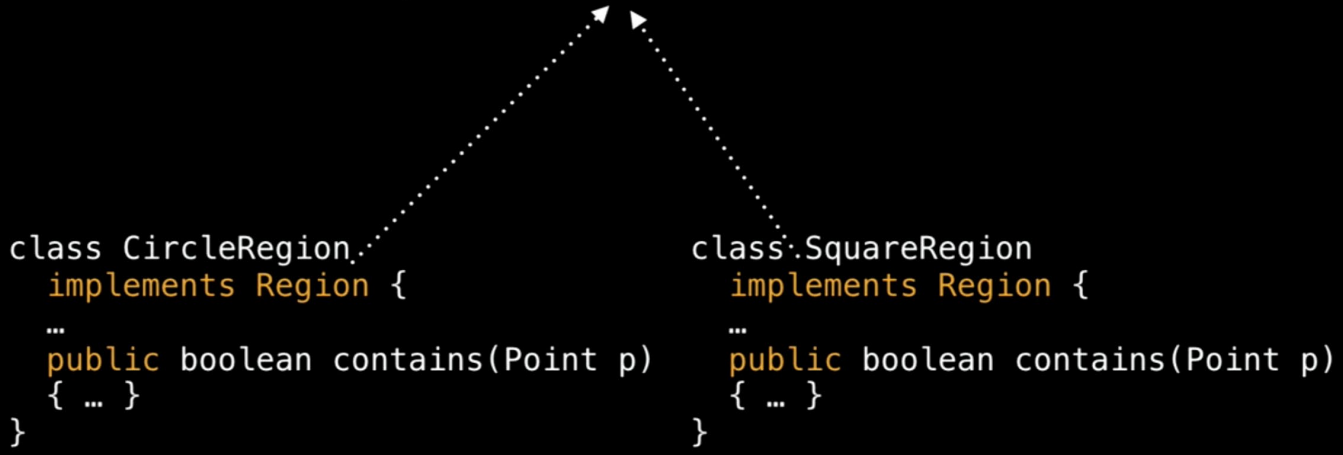
```
class CircleRegion
  implements Region {
  …
  public boolean contains(Point p)
  { … }
}
```

```
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

```
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**

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

public

```
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?

1 ~~A: 10~~ 5 ~~C: 5~~

0 ~~B: 8~~ (2) D: it's an error

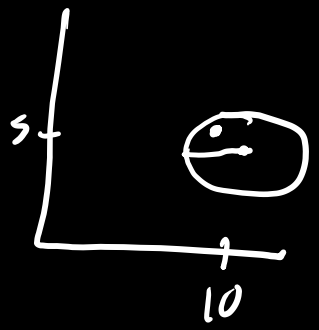
~~E:~~ something else ↳ 4?

Using an interface, we can only use methods on the interface

```
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?

13 A: true 2 C: error

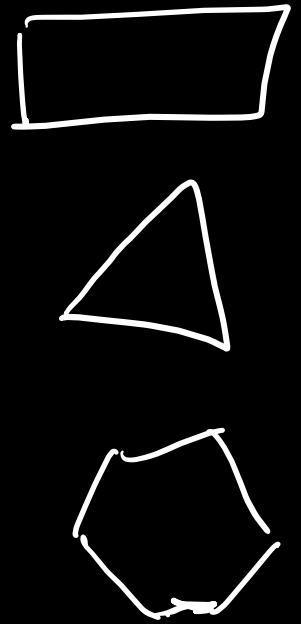
2 B: false

```
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));
}
```

or

What is the value of the `b1` field?

17 A: true ~~C: error~~

1 B: false

Using Interfaces

- Add Region interface
- Update RectRegion & CircRegion

Intersect Region

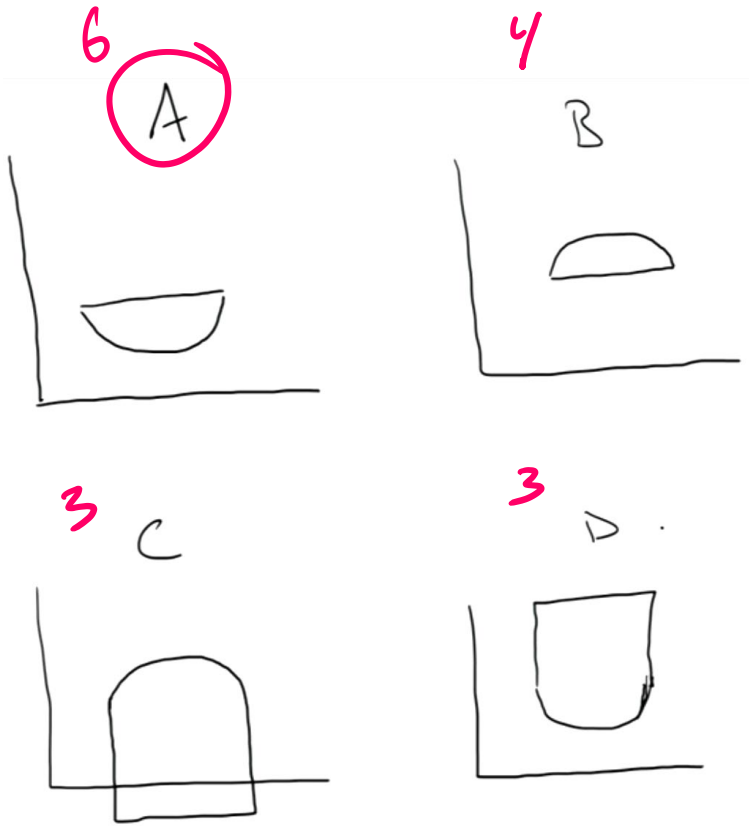
```
interface Region {
  boolean contains(Point p);
}
```

```
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);
  }
}
```

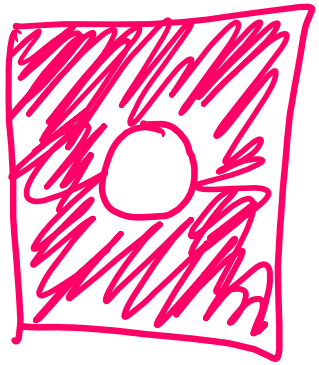
```
class IntersectRegion implements Region {
  …
  public boolean contains(Point p) {
    return this.r1.contains(p) && this.r2.contains(p);
  }
}

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;
}
```

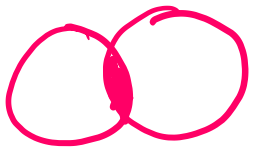


SubtractRegion



- 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?

xor



Negate

!

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?

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

```
class Point {
  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 Point {
  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;
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    this.region1 = region1;
    this.region2 = region2;
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           this.region2.contains(toCheck);
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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;
  }
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    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);
}
```

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class Point {
  private double x, y;
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       Math.pow(this.y - other.y, 2));
  }
  double xDistance(Point other) { return Math.abs(other.x - this.x); }
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  Region overlap(Region other);
}
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  }
  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);
  }
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class IntersectRegion extends ARegion {
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  IntersectRegion(Region region1, Region region2) {
    this.region1 = region1;
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           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;
  }
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class ExamplesARegion {
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  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 IntersectRection 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 Point {
  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) ||
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class IntersectRegion extends ARegion {
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  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);
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  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 IntersectRection 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);
  }
}
```

```
class UnionRegion                          {


  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


  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);
  }
}
```

```
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);
  }
}
```

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

```
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) {
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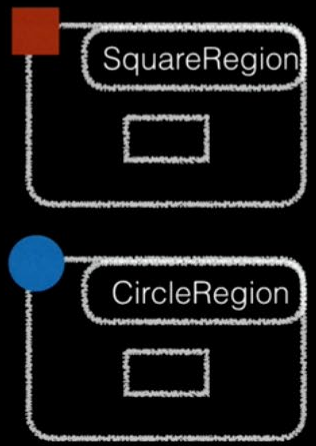

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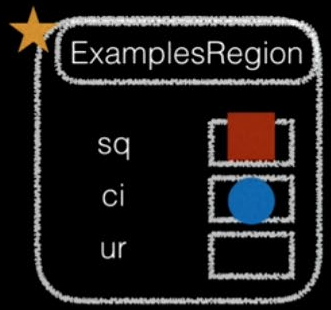

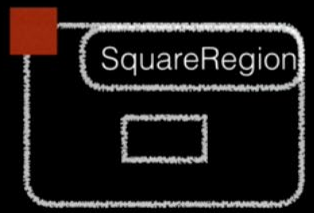

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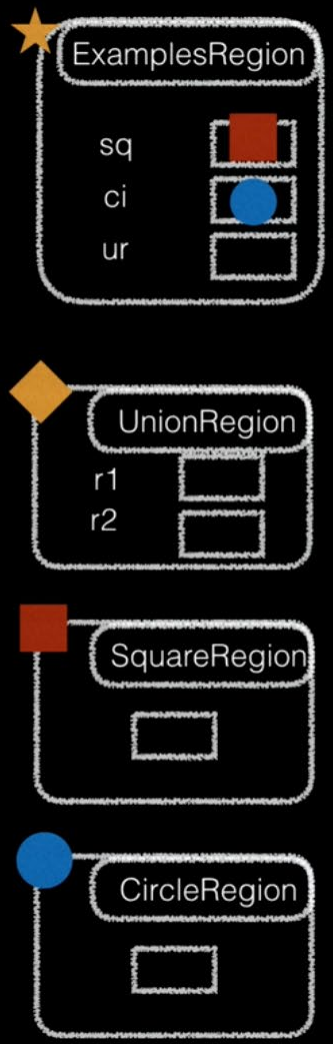

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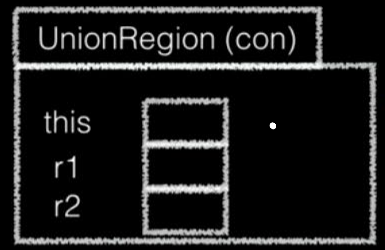

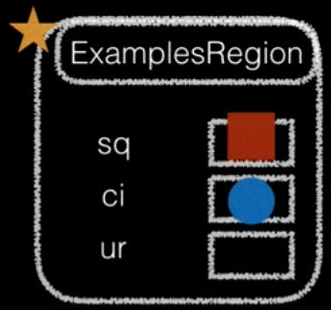

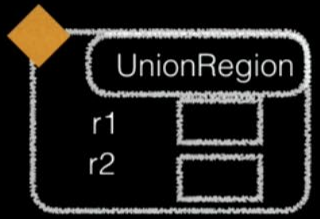

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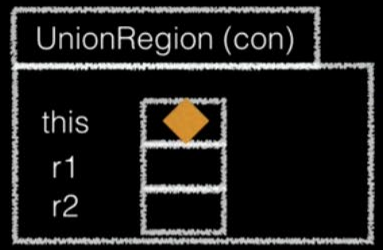

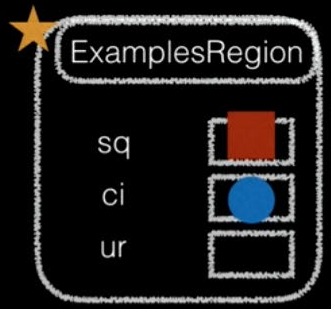

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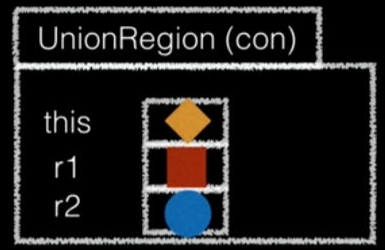

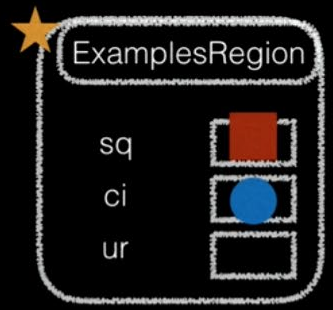

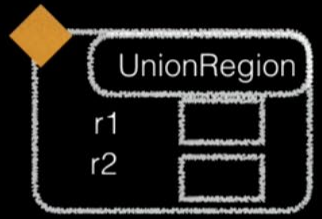

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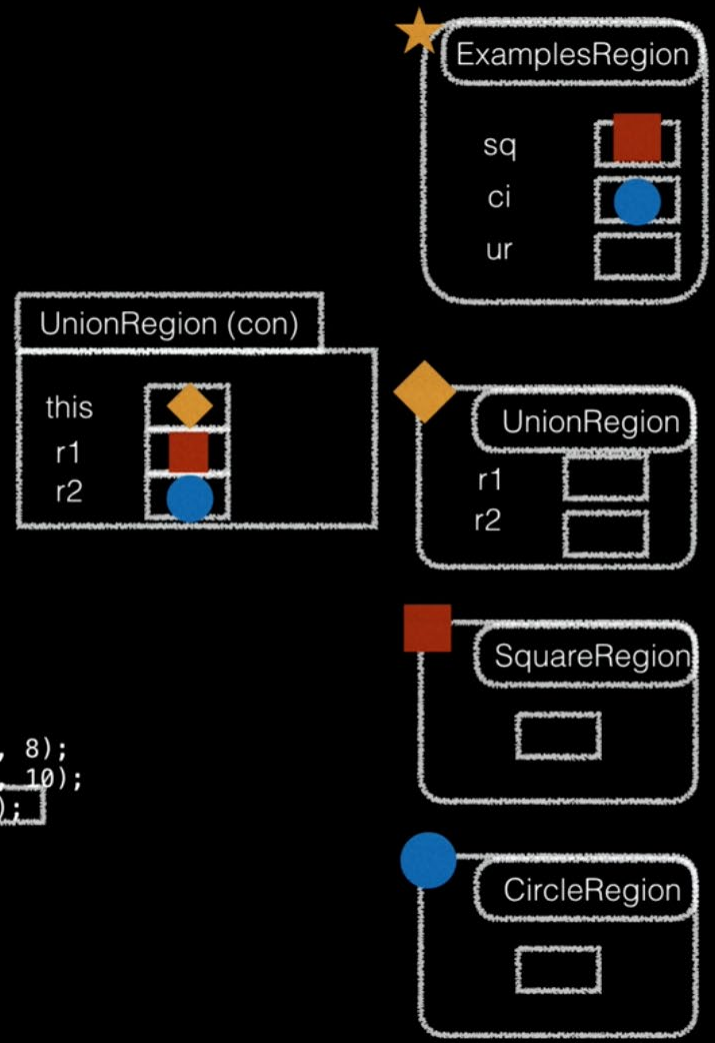

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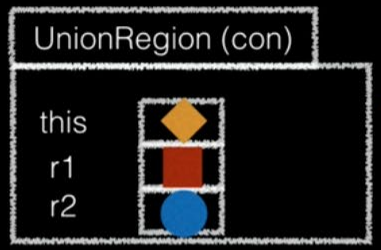

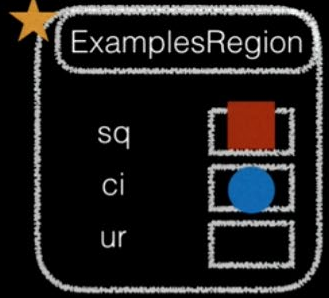

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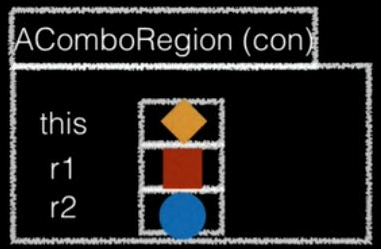

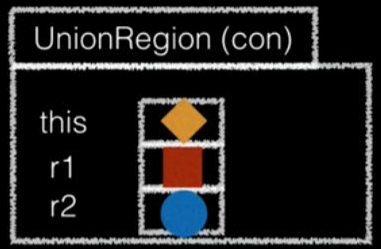

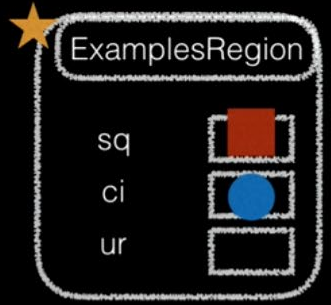

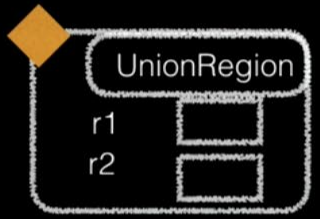

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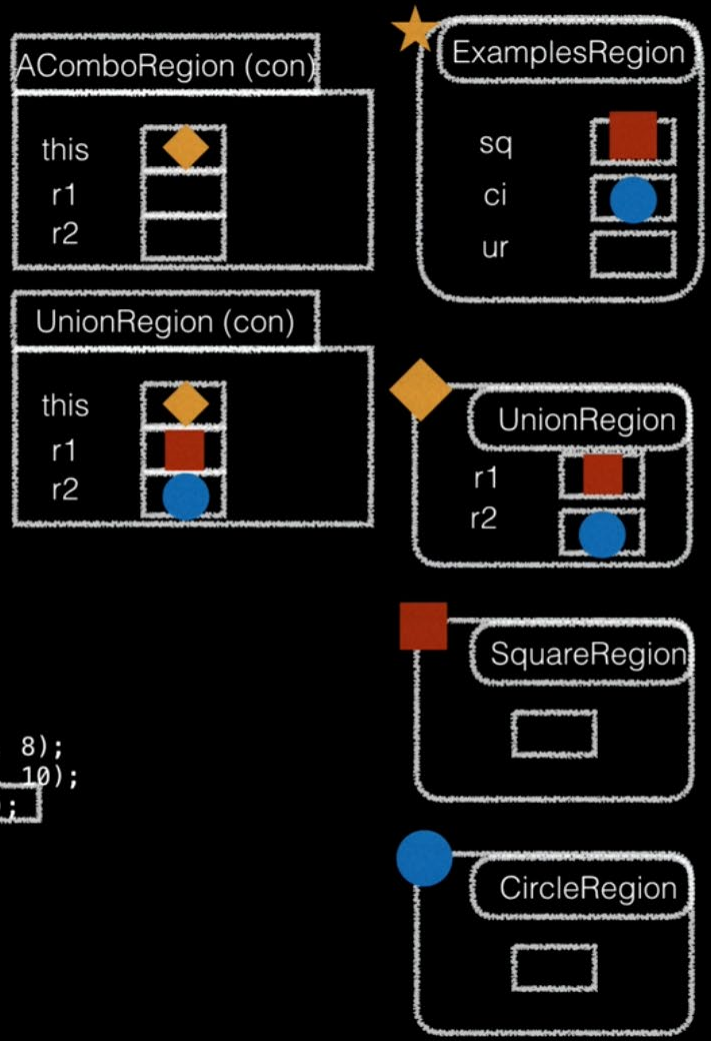

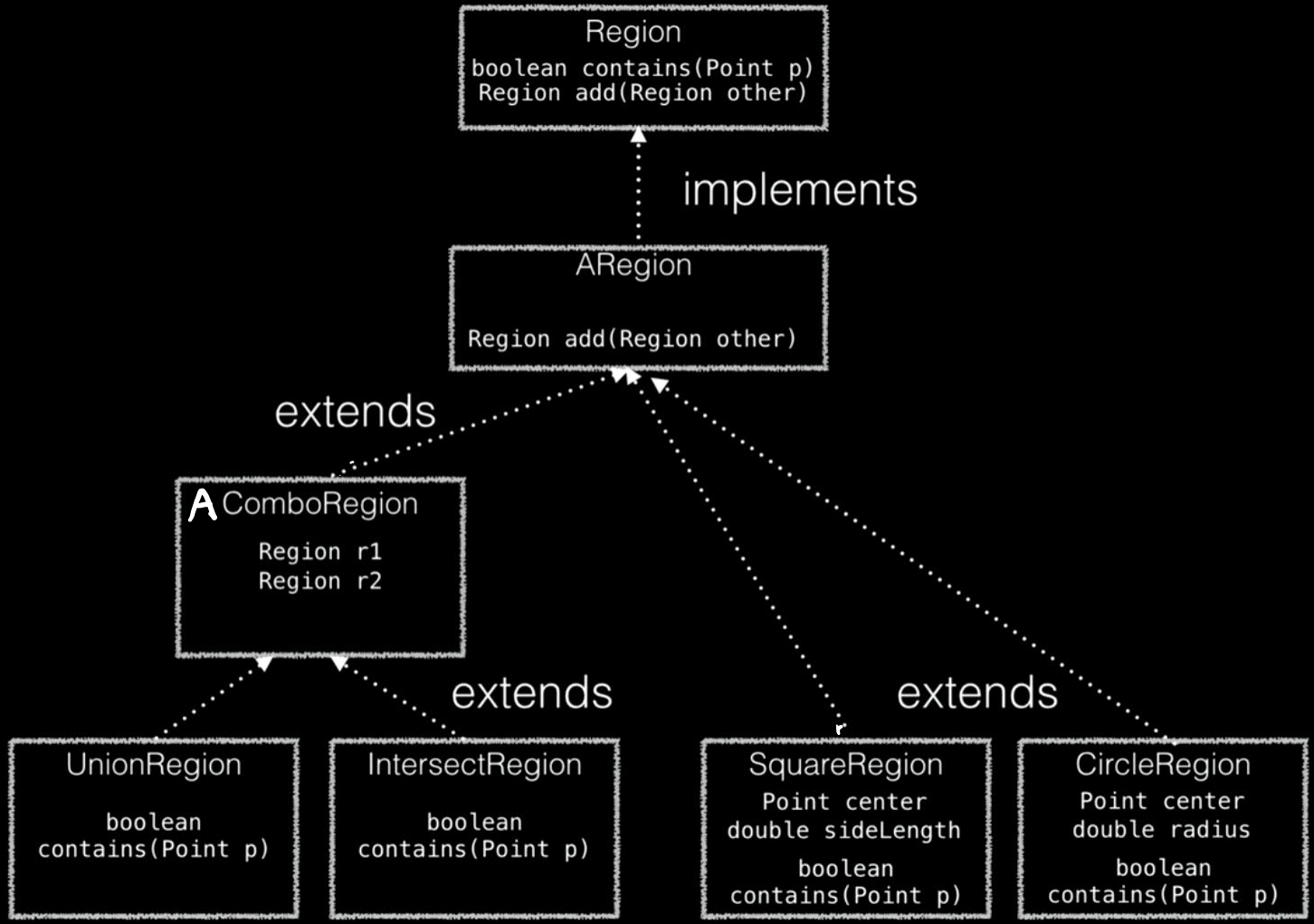
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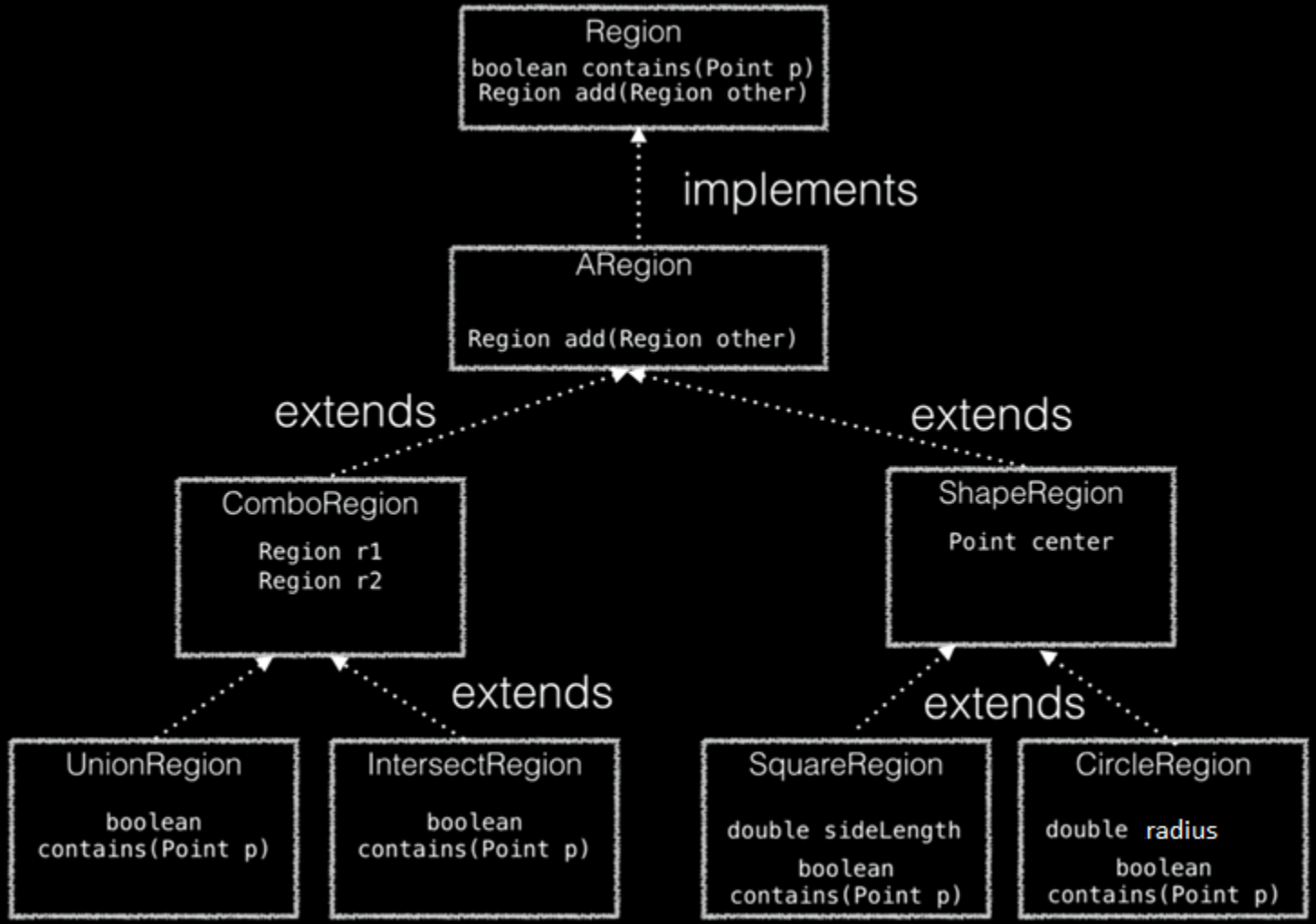
Region add(Region other)
implements
ARegion
Region add(Region other)
extends
A ComboRegion
Region r1
Region r2
extends
extends
UnionRegion
boolean
contains(Point p)
IntersectRegion
boolean
contains(Point p)
SquareRegion
Point center
double sideLength
boolean
contains(Point p)
CircleRegion
Point center
double radius
boolean
contains(Point p)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extends
UnionRegion
boolean
contains(Point p)
IntersectRegion
boolean
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SquareRegion
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CircleRegion
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