Chapter 7
A Static Visual Content System

The Design and Implementation of Multimedia Software

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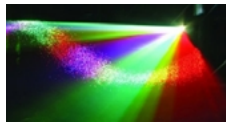
Jones and Bartlett Publishers

www.jbpub.com



About this Chapter

- Consider a comic book character that has one `BufferedImage` as its head and another as its body:

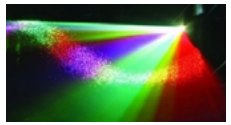
  One could create two `sampled.Content` objects and put them in one `Visualization`.

  But the character could not be treated as a coherent whole.

- Consider an illustration of a house using described content in which the door and roof must be different colors:

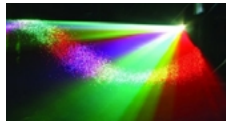
  One could create a `described.Content` object for each part of the house and add them all to a single `Visualization`.

  But the house could not be treated as a coherent whole.



Requirements

F7.1 Support visual content that has multiple component parts.

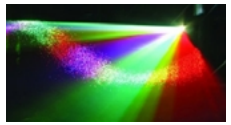


A Top-Down Approach

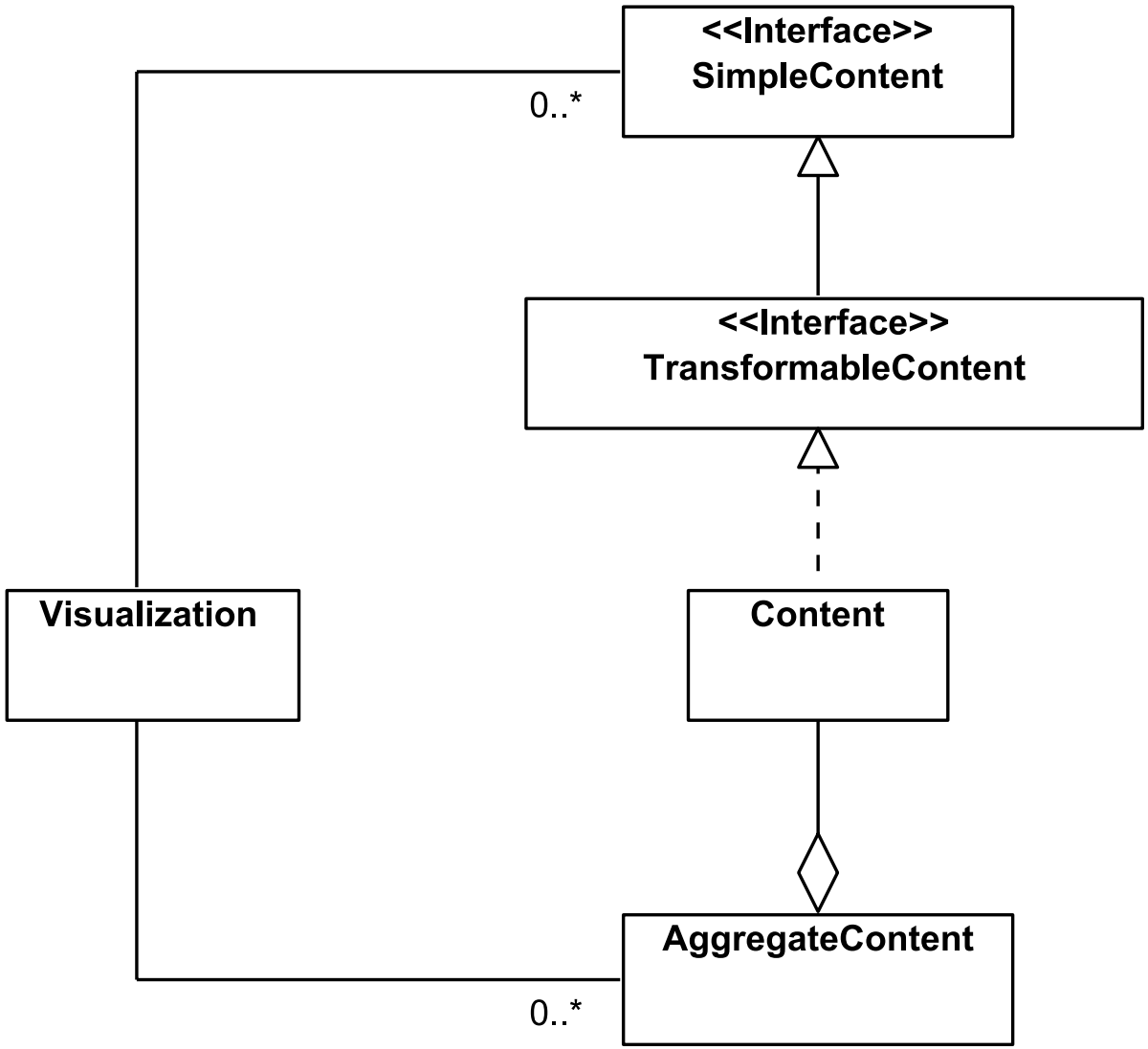
1. Consider design alternatives at a high level of abstraction.

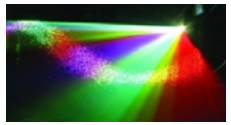
   Ignore the differences between `statik.sampled.Content` and `statik.described.Content` objects and consider only `statik.Content` objects.

2. Add the details needed to support the differences between `statik.sampled.Content` and `statik.described.Content`.



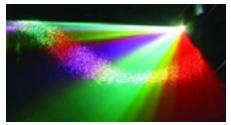
Alternative 1





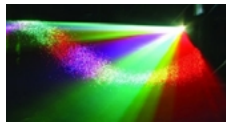
Alternative 1 - Shortcomings

What are the shortcomings?



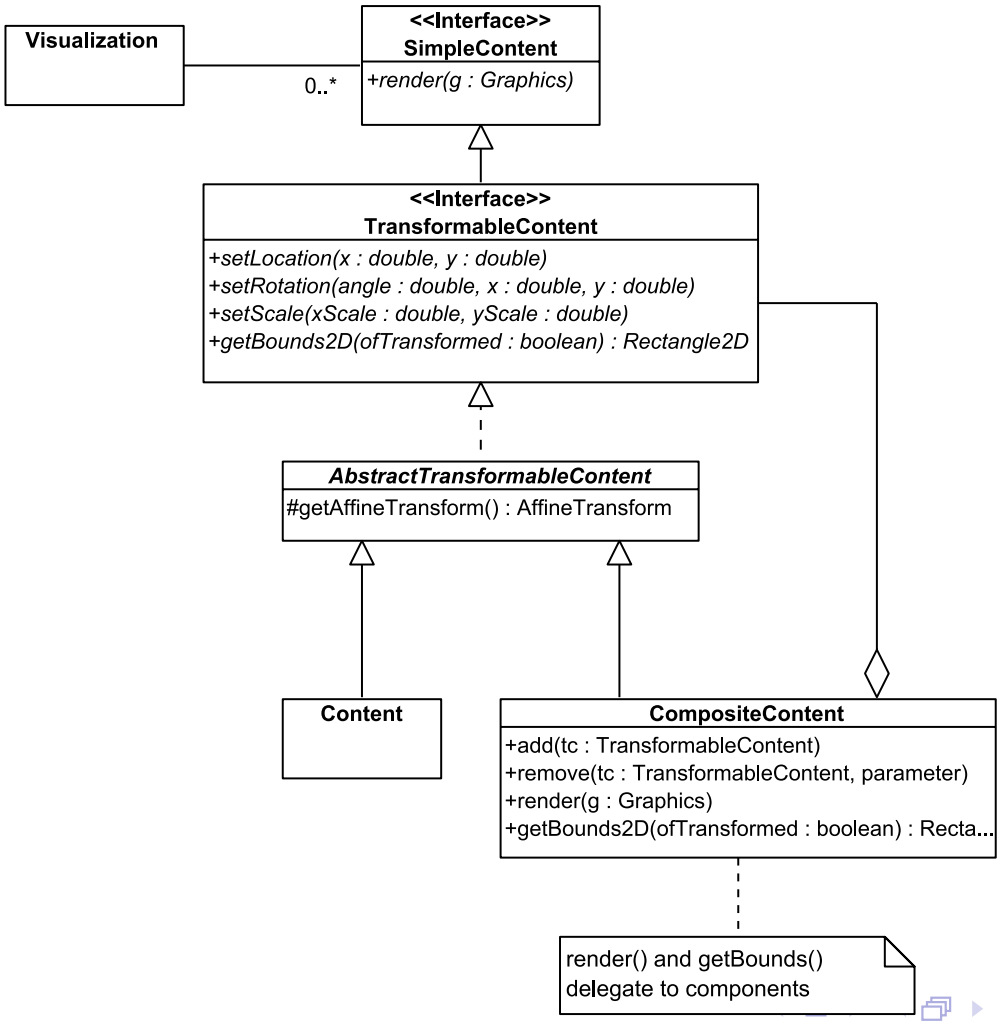
Alternative 1 - Shortcomings

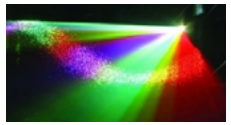
Both the `Visualization` and `VisualizationView` classes must now distinguish between `Content` objects and `TransformableContent` objects making them more complicated, more repetitive, and less cohesive.



Alternative 2

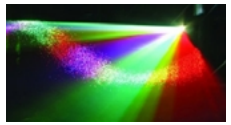
Use the Composite Pattern





Alternative 2 - Advantages

- Allows both the `Visualization` and `VisualizationView` classes to treat `SimpleContent` objects and `CompositeContent` objects in exactly the same way.
- Enables the creation of content that is very complicated.



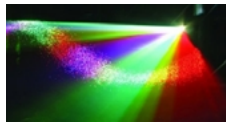
Alternative 2.1

- Approach:

  Make three ‘copies’ of the design, one for `statik.sampled.Content`, one for `statik.described.Content`, and one for either/both.

- Shortcomings:

  What are the shortcomings?



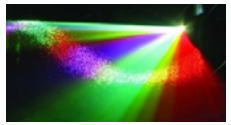
Alternative 2.1 

- Approach:

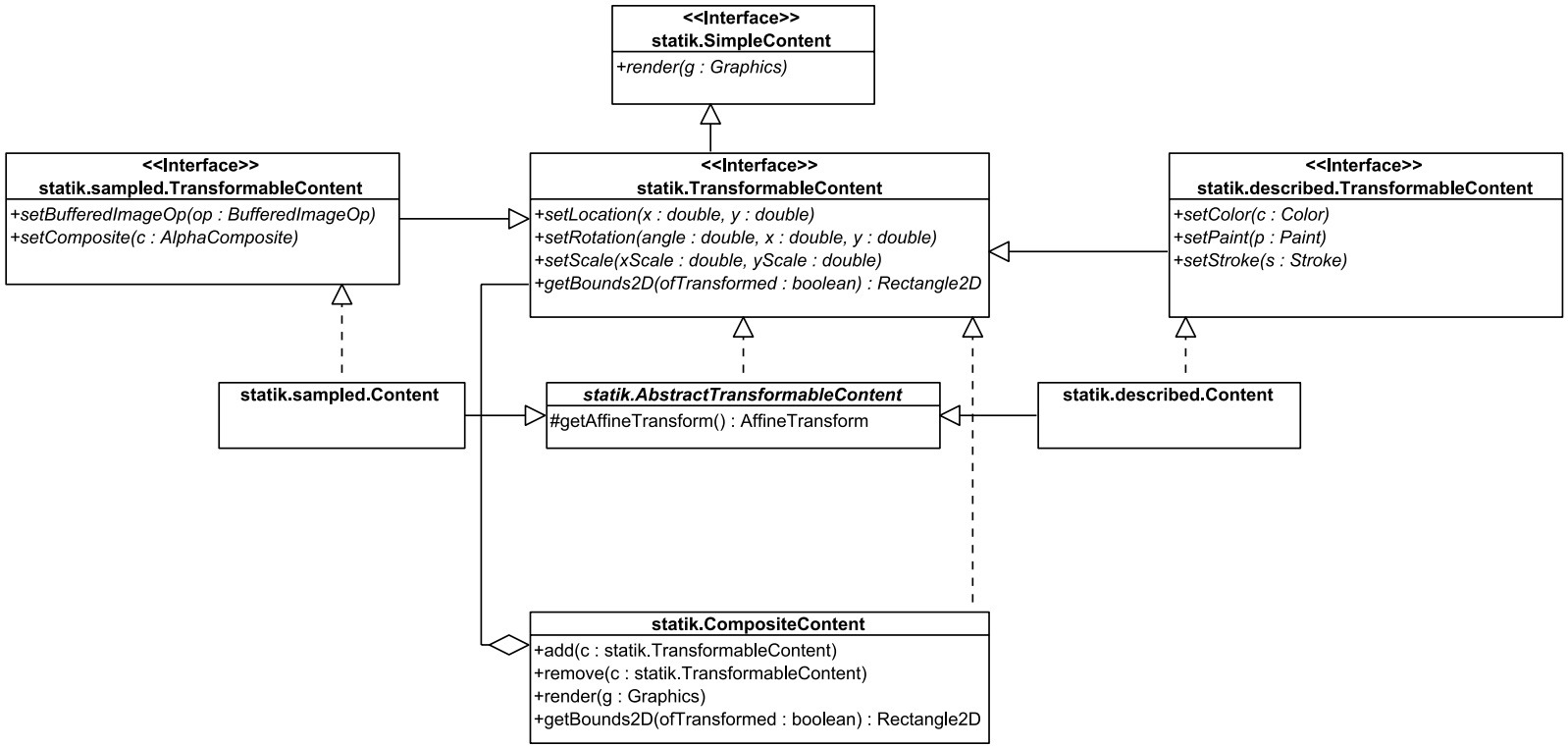
  Make three 'copies' of the design, one for `statik.sampled.Content`, one for `statik.described.Content`, and one for either/both.

- Shortcomings:

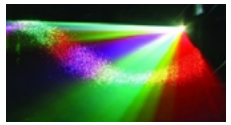
  The `statik.sampled.CompositeContent`, `statik.described.CompositeContent`, and `statik.CompositeContent` classes all must have `add()`, `remove()`, `render()`, and `getBounds2D()` methods that contain (virtually) identical code.



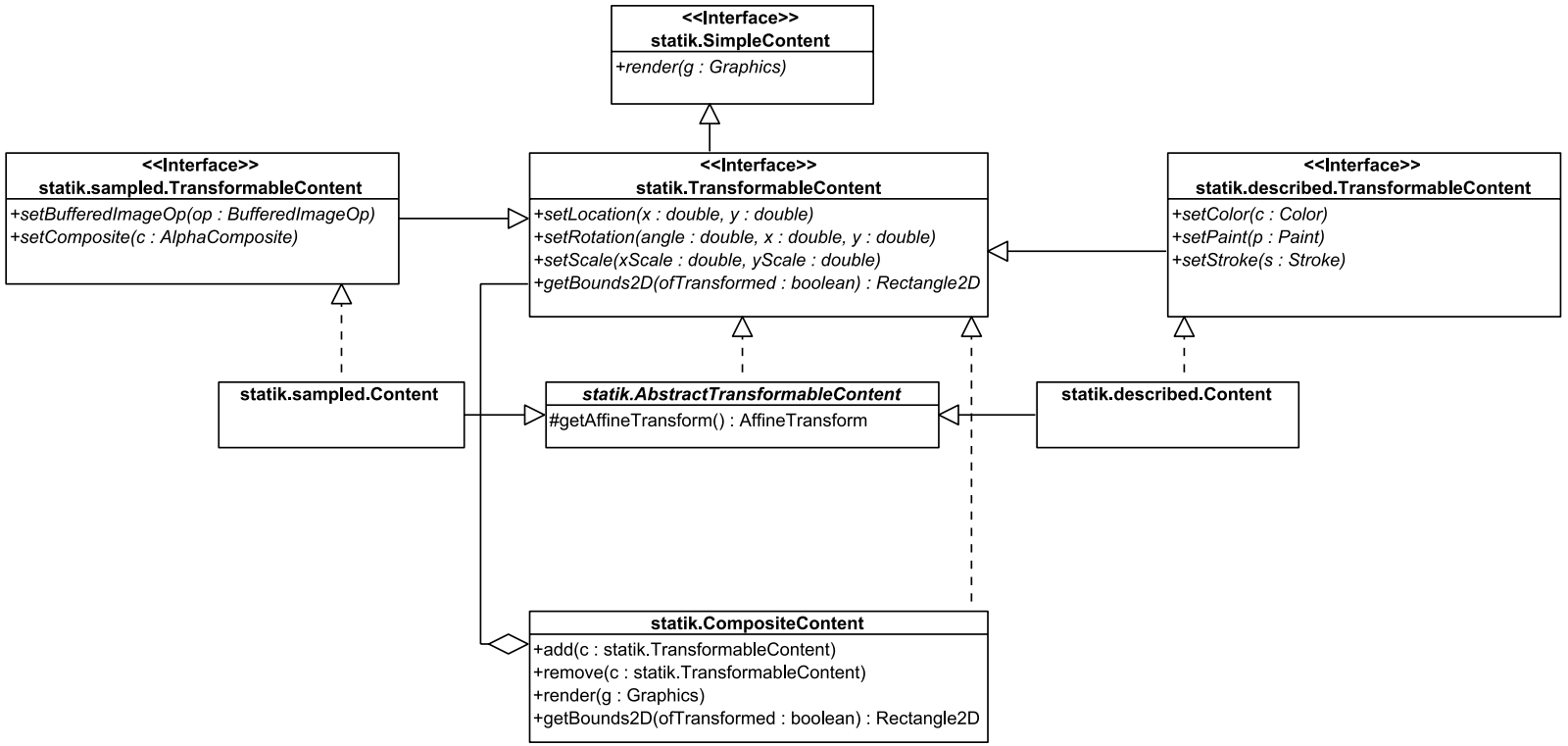
Alternative 2.2



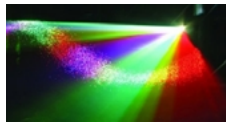
What are the shortcomings?



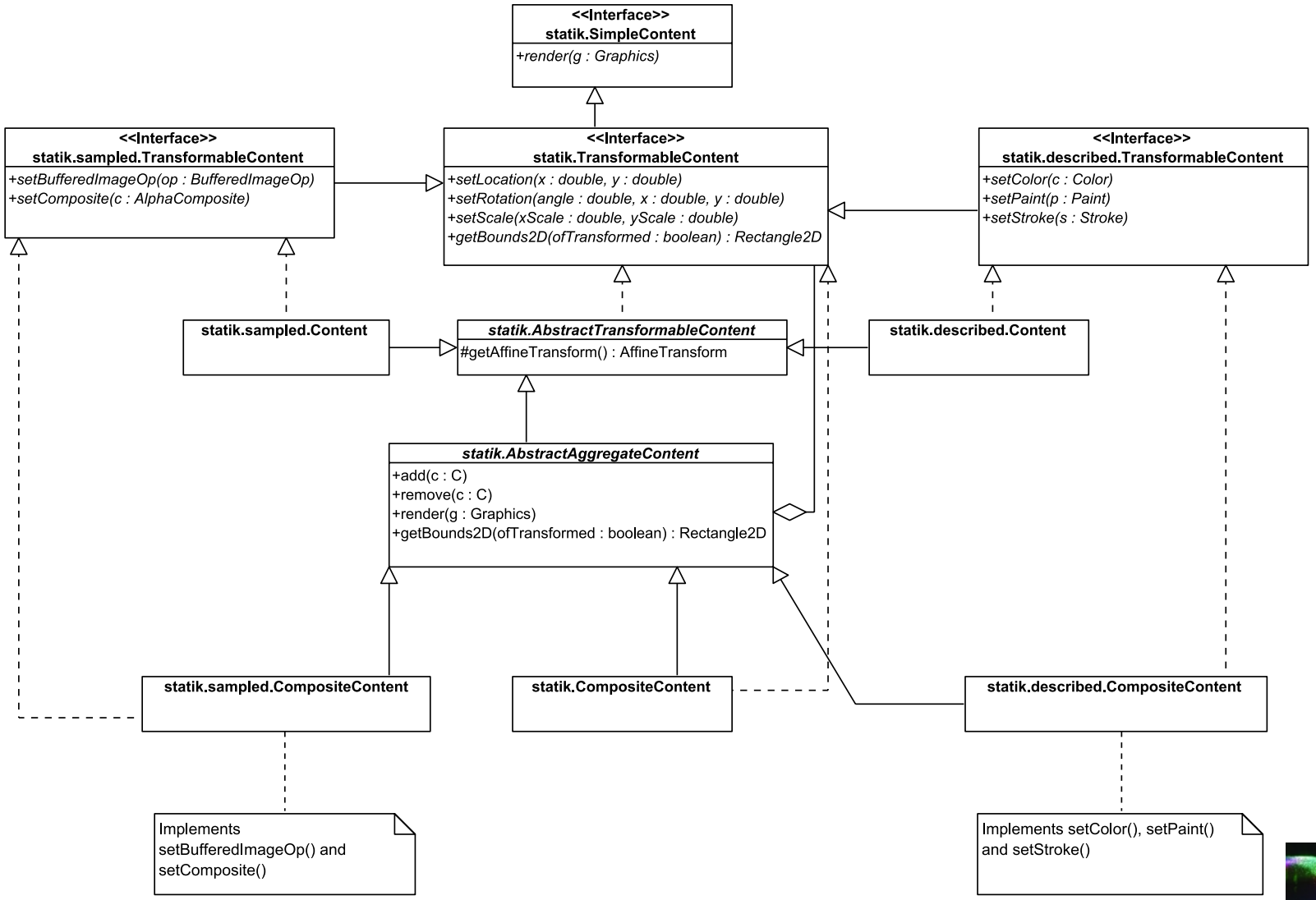
Alternative 2.2

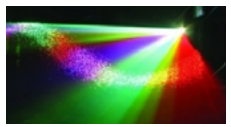


It doesn't allow operations that are either specific to `statik.sampled.Content` or `statik.described.Content` objects to be applied to `statik.CompositeContent` objects.



Alternative 2.3





Alternative 2.3 - Advantages and Disadvantages

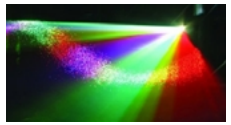
- Advantage:

  Allows for operations that are specific to `statik.sampled.Content` and `statik.described.Content`

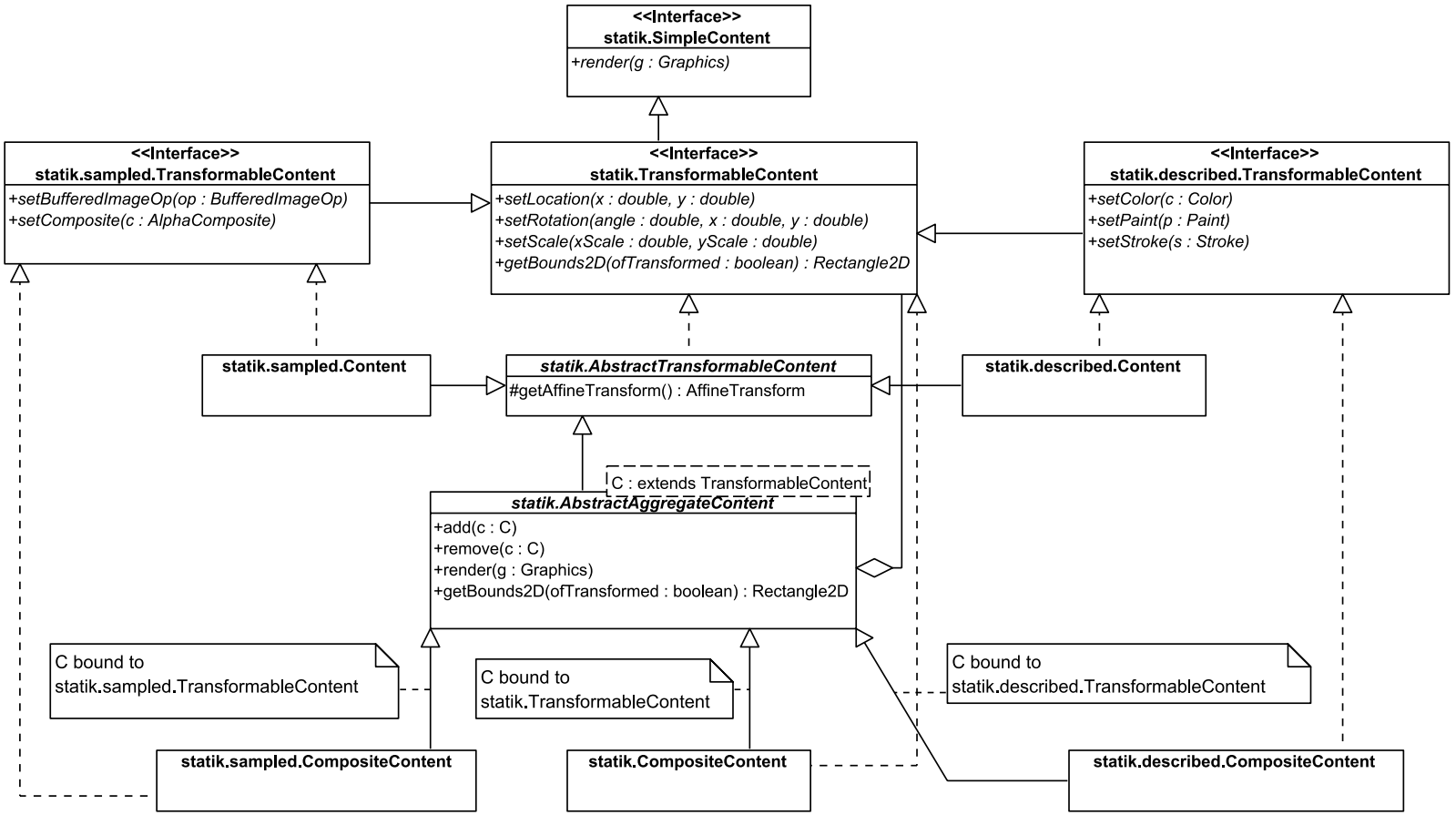
  Eliminates code duplication by moving the common code to the abstract parent.

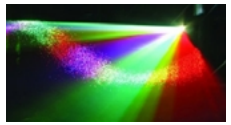
- Disadvantage:

  Since the abstract parent manages the collection, the collection must contain `statik.TransformableContent` objects, rather than the more specific `statik.sampled.Content` and `statik.described.Content` objects.



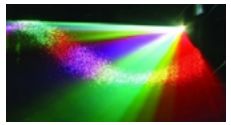
Alternative 2.4





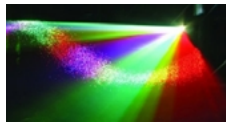
AbstractAggregateContent - Structure

```
package visual.statik;

import java.awt.*;
import java.awt.geom.*;
import java.util.*;

public abstract class
                AbstractAggregateContent<C extends TransformableContent>
       extends  AbstractTransformableContent
{
    // A LinkedList is used to order the components.
    // Since we don't expect many components to be removed
    // this doesn't raise efficiency concerns.
    //
    // Alternatively, we could have a z-order.
    protected LinkedList<C>        components;

    public AbstractAggregateContent()
    {
       super();
       components = new LinkedList<C>();
    }
}
```



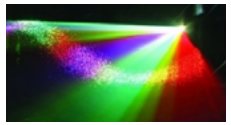
AbstractAggregateContent - Content Management

```
public void add(C component)
{
   components.add(component);
}

public Iterator<C> iterator()
{
   return components.iterator();
}

public void remove(C component)
{
   components.remove(component);
}
```



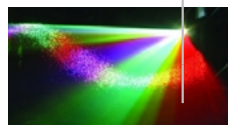
AbstractAggregateContent - Rendering

```
public void render(Graphics g)
{
   Iterator<C>   i;
   C             component;

   i = components.iterator();
   while (i.hasNext())
   {
      component = i.next();

      component.setLocation(x, y);
      component.setRotation(angle, xRotation, yRotation);
      component.setScale(xScale, yScale);

      component.render(g);
   }
}
```



AbstractAggregateContent - Bounds

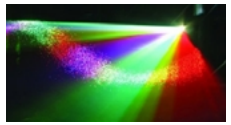
```
public Rectangle2D getBounds2D(boolean ofTransformed)
{
   double                maxX, maxY, minX, minY, rx, ry;
   Iterator<C>           i;
   Rectangle2D           bounds;
   TransformableContent  component;

   maxX = Double.NEGATIVE_INFINITY;
   maxY = Double.NEGATIVE_INFINITY;
   minX = Double.POSITIVE_INFINITY;
   minY = Double.POSITIVE_INFINITY;

   i = components.iterator();
   while (i.hasNext())
   {
      component = i.next();
      bounds    = component.getBounds2D(ofTransformed);

      if (bounds != null)
      {
         rx = bounds.getX();
         ry = bounds.getY();
         if (rx < minX) minX = rx;
         if (ry < minY) minY = ry;

         rx = bounds.getX() + bounds.getWidth();
         ry = bounds.getY() + bounds.getHeight();
         if (rx > maxX) maxX = rx;
```



AbstractAggregateContent - Bounds (cont.)

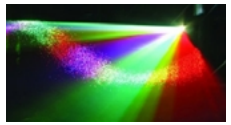
```
            if (ry > maxY) maxY = ry;
        }
    }
    // Note: We could, instead, use an object pool
    return new Rectangle2D.Double(minX, minY, maxX-minX, maxY-minY);
}
```

For simplicity, this implementation does not store bounds, it calculates them when needed using the `getBounds2D()` method in the `TransformableContent` objects. Alternatively, this class could calculate the bounds whenever they change.



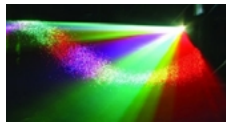
CompositeContent

```
package visual.statik;

public class      CompositeContent
       extends    AbstractAggregateContent<TransformableContent>
       implements TransformableContent
{
    public CompositeContent()
    {
       super();
    }
}
```



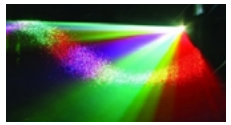
CompositeContent - Structure

```
package visual.statik.sampled;

import java.awt.Composite;
import java.awt.image.BufferedImageOp;
import java.util.Iterator;

import visual.statik.AbstractAggregateContent;

public class      CompositeContent
       extends    AbstractAggregateContent<TransformableContent>
       implements TransformableContent
{
    public CompositeContent()
    {
       super();
    }
}
```



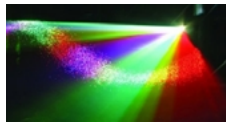
CompositeContent - setBufferedImageOp()

```
public void setBufferedImageOp(BufferedImageOp op)
{
   Iterator<TransformableContent>  i;

   i = iterator();
   while (i.hasNext())
   {
      i.next().setBufferedImageOp(op);
   }
}
```



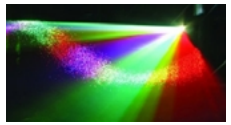
CompositeContent - setComposite()

```
public void setComposite(Composite c)
{
   Iterator<TransformableContent>  i;

   i = iterator();
   while (i.hasNext())
   {
      i.next().setComposite(c);
   }
}
```



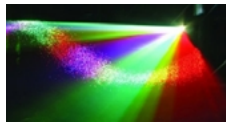
CompositeContent - Structure

```
package visual.statik.described;

import java.awt.*;
import java.util.Iterator;

import visual.statik.AbstractAggregateContent;

public class       CompositeContent
       extends     AbstractAggregateContent<TransformableContent>
       implements TransformableContent
{
    public CompositeContent()
    {
       super();
    }
}
```



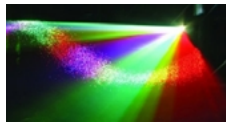
CompositeContent - setColor()

```
public void setColor(Color color)
{
   Iterator<TransformableContent>  i;

   i = iterator();
   while (i.hasNext())
   {
      i.next().setColor(color);
   }
}
```



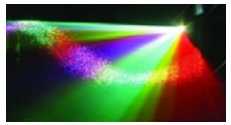
CompositeContent - setPaint()

```
public void setPaint(Paint paint)
{
   Iterator<TransformableContent>  i;

   i = iterator();
   while (i.hasNext())
   {
      i.next().setPaint(paint);
   }
}
```

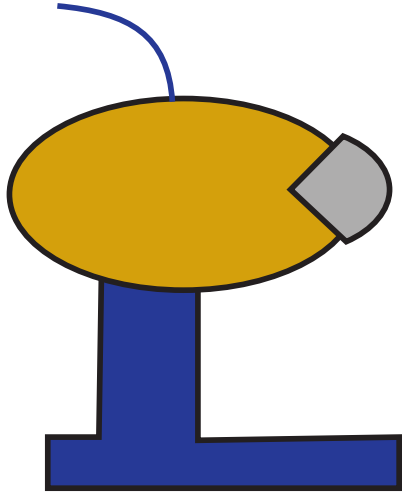


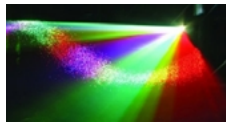
CompositeContent - setStroke()

```
public void setStroke(Stroke stroke)
{
   Iterator<TransformableContent>  i;

   i = iterator();
   while (i.hasNext())
   {
      i.next().setStroke(stroke);
   }
}
```

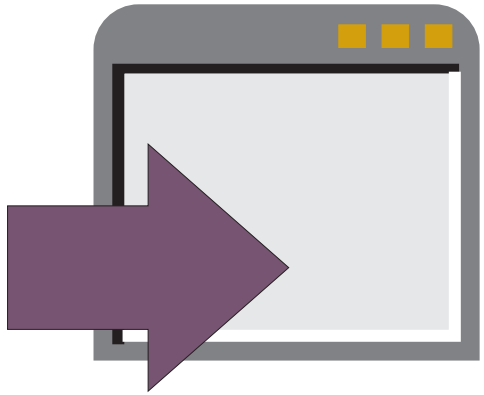


Introducing Buzzy





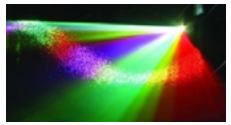
Introducing Buzzy – Demonstration



In `examples/chapter`:

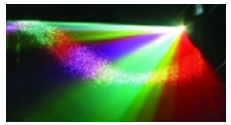
Buzzy.html

```
java -cp Buzzy.jar BuzzyApplication
```



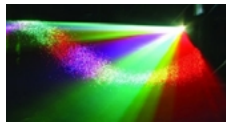
Buzzy - Structure

```
import java.awt.*;
import java.awt.geom.*;
import javax.swing.*;

import visual.statik.described.*;

public class BoringBuzzy extends CompositeContent
{
}
```



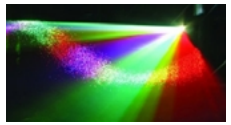
Buzzy - Constructor

```
public BoringBuzzy()
{
   super();
   Arc2D.Float            helmetShape, visorShape;
   BasicStroke            stroke;
   Color                  black, gold, gray, purple;
   CompositeContent       head;
   Content                body, hair, helmet, visor;
   Path2D.Float           bodyShape;
   QuadCurve2D.Float      hairShape;

   black  = Color.BLACK;
   gold   = new Color(0xc2,0xa1,0x4d);
   gray   = new Color(0xaa,0xaa,0xaa);
   purple = new Color(0x45,0x00,0x84);

   stroke = new BasicStroke();
}
```



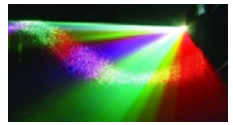
Buzzy - Body

```
bodyShape = new Path2D.Float();
bodyShape.moveTo( 20, 50);
bodyShape.lineTo( 20, 70);
bodyShape.lineTo( 20, 90);
bodyShape.lineTo( 10, 90);
bodyShape.lineTo( 10,100);
bodyShape.lineTo( 80,100);
bodyShape.lineTo( 80, 90);
bodyShape.lineTo( 40, 90);
bodyShape.lineTo( 40, 70);
bodyShape.lineTo( 40, 50);
bodyShape.closePath();
body = new Content(bodyShape, black, purple, stroke);
add(body);
```



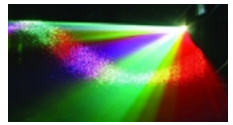
Buzzy - Head

```
head = new CompositeContent();
add(head);
```



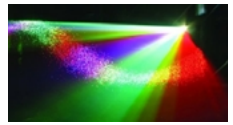
Buzzy - Hair (?)

```
hairShape = new QuadCurve2D.Float(10,2,40,10,30,25);
hair = new Content(hairShape, purple, null, stroke);
head.add(hair);
```



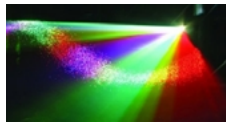
Buzzy - Helmet

```
helmetShape = new Arc2D.Float(2,20,70,40,2,360,Arc2D.OPEN);
helmet=new Content(helmetShape, black, gold, stroke);
head.add(helmet);
```

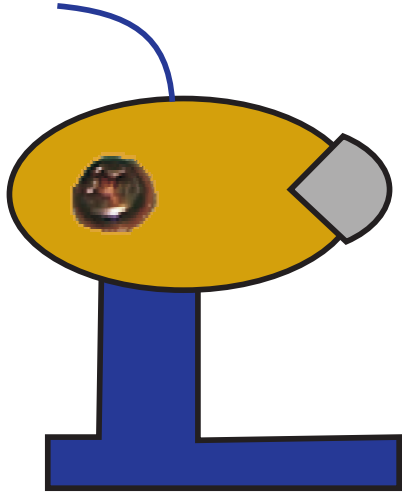


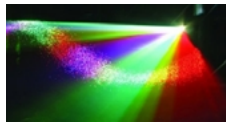
Buzzy - Visor

```
visorShape = new Arc2D.Float(40,25,35,30,315,90,Arc2D.PIE);
visor=new Content(visorShape, black, gray, stroke);
head.add(visor);
```



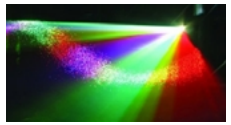
Buzzy with a Fancy Helmet





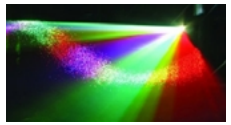
Buzzy with a Fancy Helmet - Structure

```
import java.awt.*;
import java.awt.geom.*;
import javax.swing.*;
import io.*;


public class FancyBuzzy extends visual.statik.CompositeContent
{
}
```



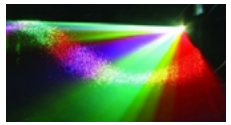
Buzzy with a Fancy Helmet - Declarations

```
ResourceFinder                          finder;
visual.statik.CompositeContent          head;
visual.statik.described.Content         body, hair, helmet, visor;
visual.statik.sampled.Content           screw;
visual.statik.sampled.ContentFactory    factory;
```



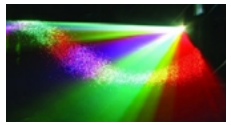
Buzzy with a Fancy Helmet - Logo

```
finder  = ResourceFinder.createInstance(this);
factory = new visual.statik.sampled.ContentFactory(finder);
screw = factory.createContent("screw.png", 4);
```

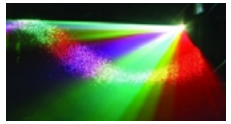


Buzzy with a Fancy Helmet - Head

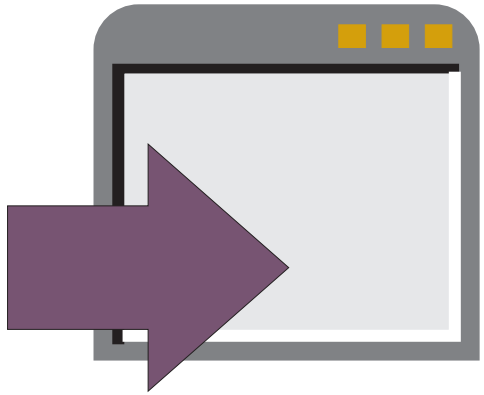
```
head = new visual.statik.CompositeContent();
head.add(hair);
head.add(helmet);
head.add(screw);
head.add(visor);

add(head);
```



Buzzy in the Woods



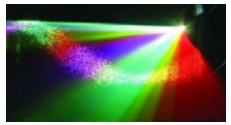
Buzzy in the Woods – Demonstration



In `examples/chapter`:

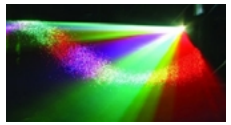
Visualization.html

```
java -cp Visualization.jar VisualizationApplication
```



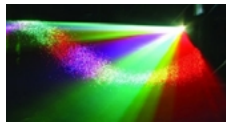
Buzzy in the Woods - The Woods

```
finder  = ResourceFinder.createInstance(this);
factory   = new ContentFactory(finder);
opFactory = BufferedImageOpFactory.createFactory();

woods  = factory.createContent("woods.png", 3);
woods.setLocation(0,0);
woods.setBufferedImageOp(opFactory.createBlurOp(3));
```



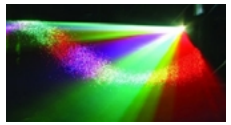
Buzzy in the Woods - Buzzy

```
buzzy  = new FancyBuzzy();
buzzy.setLocation(200, 318);
```



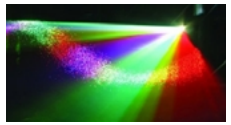
Buzzy in the Woods - The Visualization

```
visualization = new Visualization();
view          = visualization.getView();

view.setBounds(0,0,471,418);
view.setSize(471,418);

visualization.add(woods);
visualization.add(buzzy);
```

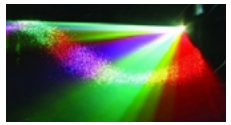


Buzzy in the Woods - The Content Pane

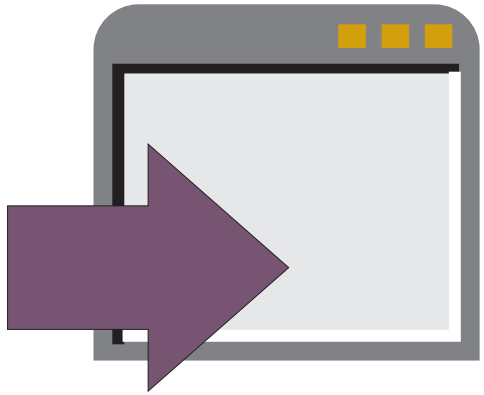
```
// The content pane
contentPane = (JPanel)rootPaneContainer.getContentPane();
contentPane.add(view);
```



Picture-in-a-Picture



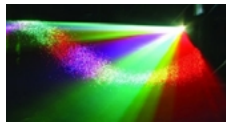
Picture-in-a-Picture – Demonstration



In `examples/chapter`:

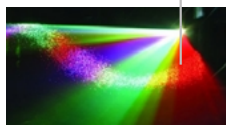
StaticPIP.html

```
java -cp StaticPIP.jar StaticPIPApplication
```



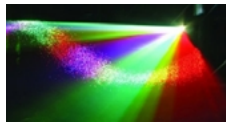
Picture-in-a-Picture - Structure

```
import java.awt.*;
import java.awt.geom.*;
import javax.swing.*;

import app.*;
import io.*;
import visual.*;
import visual.statik.sampled.*;

public class   StaticPIPApp
       extends AbstractMultimediaApp
{
    public void init()
    {
       BufferedImageOpFactory        opFactory;
       Content                       woods, house;
       ContentFactory                factory;
       FancyBuzzy                    buzzy;
       JPanel                        contentPane;
       ResourceFinder                finder;
       Visualization                 model1, model2;
       VisualizationRenderer         renderer1, renderer2;
       VisualizationView             view1, view2;

       finder  = ResourceFinder.createInstance(this);
       factory   = new ContentFactory(finder);
       opFactory = BufferedImageOpFactory.createFactory();
```



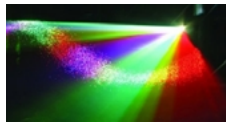
Picture-in-a-Picture - Structure (cont.)

```
    }
}
```



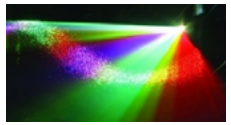
Picture-in-a-Picture - One Visualization

```
woods  = factory.createContent("woods.png",
                               3);
woods.setLocation(0,0);
woods.setBufferedImageOp(opFactory.createBlurOp(3));

buzzy  = new FancyBuzzy();
buzzy.setLocation(200, 318);

model1 = new Visualization();
model1.add(woods);
model1.add(buzzy);

view1     = model1.getView();
renderer1 = view1.getRenderer();
view1.setRenderer(new ScaledVisualizationRenderer(renderer1,
                                                  471.0,
                                                  418.0));
view1.setBounds(0,0,471,418);
view1.setSize(471,418);
```



Picture-in-a-Picture - The Other Visualization

```
house = factory.createContent("house.png",
                              3);
house.setLocation(0,0);

model2 = new Visualization();
model2.add(house);

view2     = model2.getView();
renderer2 = view2.getRenderer();
view2.setRenderer(new ScaledVisualizationRenderer(renderer2,
                                                  525.0,
                                                  375.0));
view2.setBounds(50,50,160,120);
view2.setSize(160,120);
```



Picture-in-a-Picture - The Content Pane

```
// The content pane
contentPane = (JPanel)rootPaneContainer.getContentPane();
contentPane.add(view2);
contentPane.add(view1);
```