Hand-on 4 Design Patterns

April 2023

Outline

Reminder on previous session: Design of a Drawing App

1/ Model-View-Controller pattern
2/ Publish&Subscribe pattern
3/ core domain classes (Text, Line, Rectangle, Circle, ..)
4/ extension classes: Composite, Proxy, Adapter (example: Img)
5/ Visitor pattern on domain classes.. Model to View
6/ State pattern for mouse click handler
7/ Command pattern for undo-redo..

Objective of this Hands-On

Implements the patterns
Obtain a minimalist running application

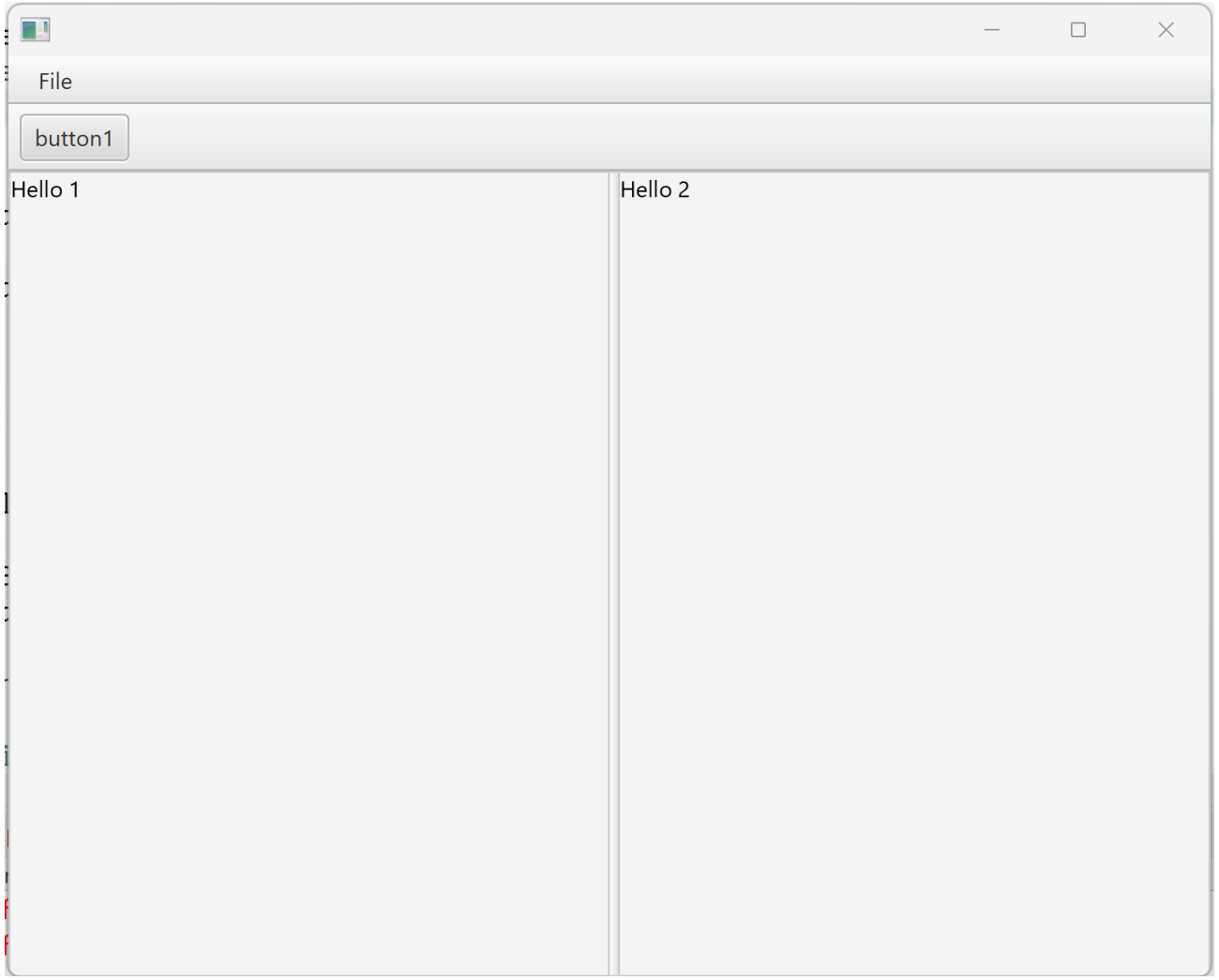
Easy:
Fully Guided
& Using code snippets

Step 0 : Create/import a project

with maven pom.xml
with javafx <dependency>
with a public static void main(String[] args)
with a javafx App

… cf next

Step 0: Run … Expected GUI Result



Step 0 : clone/download

https://github.com/Arnaud-Nauwynck/javafx-whiteapp

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README.md

A Minimalist javafx white App

About

a minimalist White Application for javafx

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it contains:

javafx dependency in maven pom.xml, mainly:

```
<dependency>
  <groupId>org.openjfx</groupId>
  <artifactId>javafx-controls</artifactId>
  <version>${javafx.version}</version>
</dependency>
```

a java Main to run :

```
import fr.an.tests.javafxwhiteapp.ui.SimpleApp;
import javafx.application.Application;

public class SimpleAppMain {
        public static void main(String[] args) {
                Application.launch(SimpleApp.class, args);
        }
}
```

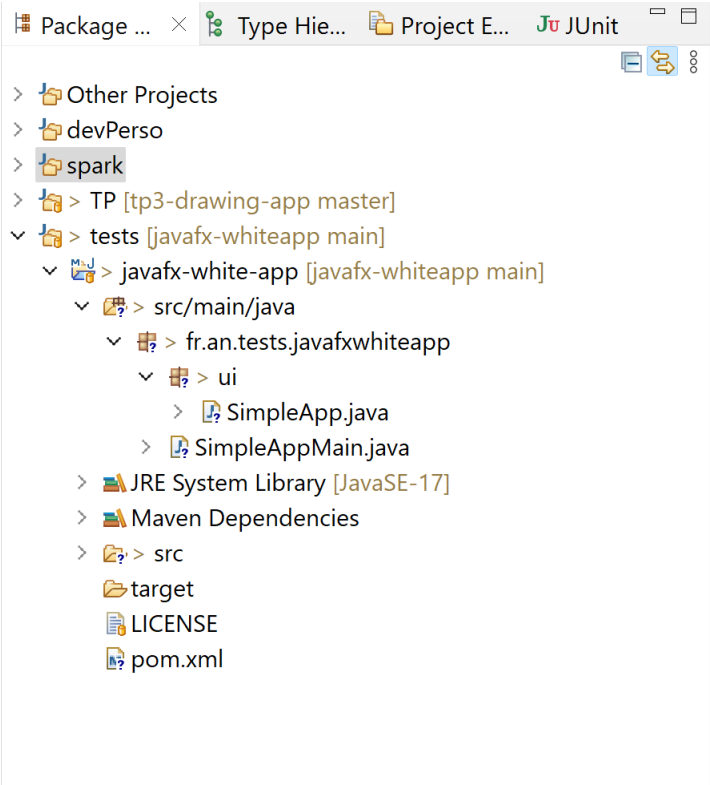
a javafx Application with

```
 MenuBar
   -> "File" Menu
     -> "Open" MenuItem
     -> "Save" MenuItem
 Toolbar
   -> a Button
 a SplitPane
   -> View1 on left
   -> View2 on right
```

See code:

```
import javafx.application.Application;
```

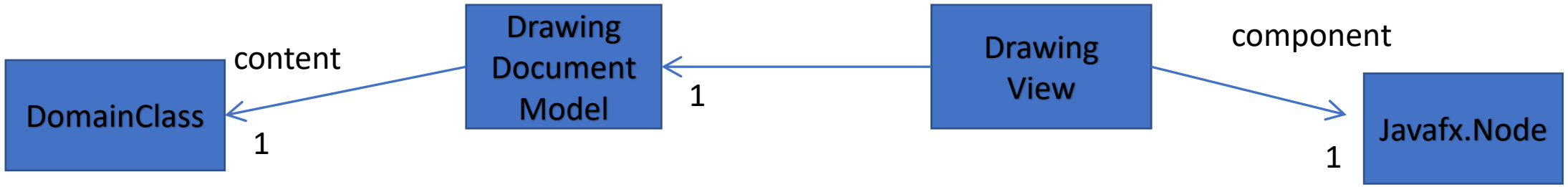
Step 1: Import in Eclipse/Idea + Run It



SimpleAppMain.java | SimpleApp.java

```java
package fr.an.tests.javafxwhiteapp;

import fr.an.tests.javafxwhiteapp.ui.SimpleApp;

public class SimpleAppMain {

    public static void main(String[] args) {
        Application.launch(SimpleApp.class, args);
    }
}
```

Step 1 : MVC Design Pattern Model-View-(Controler)

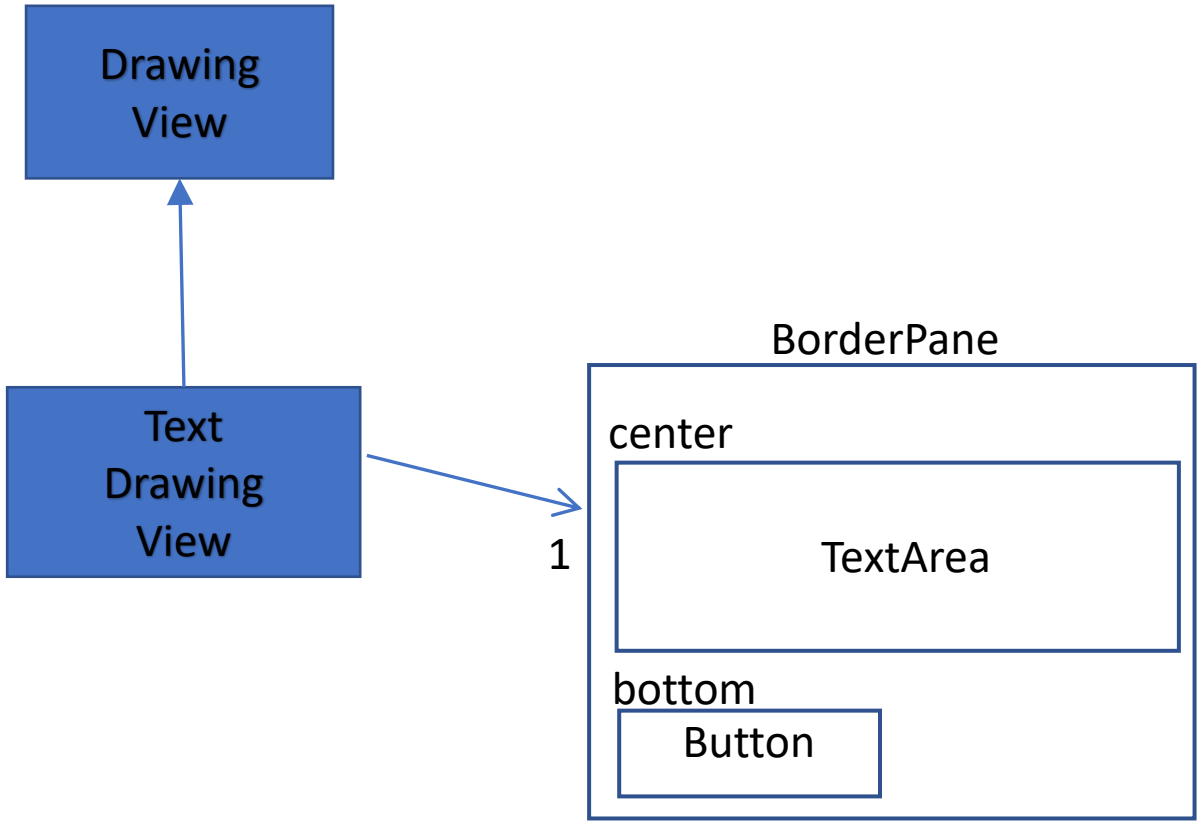


Step 1 : code ..

```java
public class DrawingDocModel {

  public String documentName;

  // to be replaced next
  // by Drawing AST classes
  public String content;


  // more later: Publisher design-pattern

}
```

```java
public abstract class DrawingView {

protected DrawingDocModel model;

public DrawingView(DrawingDocModel model) {
   this.model = model;
}

public abstract javafx.scene.Node getComponent();

 // more later: Subscriber design-pattern

}
```

Step 2: create a simple (text) DrawingView sub-class



Step 2 code

```java
public class TextDrawingView extends DrawingView {

protected BorderPane component;
protected TextArea textArea;
protected Button applyButton;

public TextDrawingView(DrawingDocModel model) {
  super(model);
  this.component = new BorderPane();
  this.textArea = new TextArea();
  component.setCenter(textArea);
  this.applyButton = new Button("Apply");
  component.setBottom(applyButton);
  refreshModelToView();
}
```

```java
@Override
public Node getComponent() {
  return component;
}

public void refreshModelToView() {
  String text = model.getContent();
  textArea.setText(text);
}
```

Step 3: in main app
instanciate 1 model and bind 2 Views

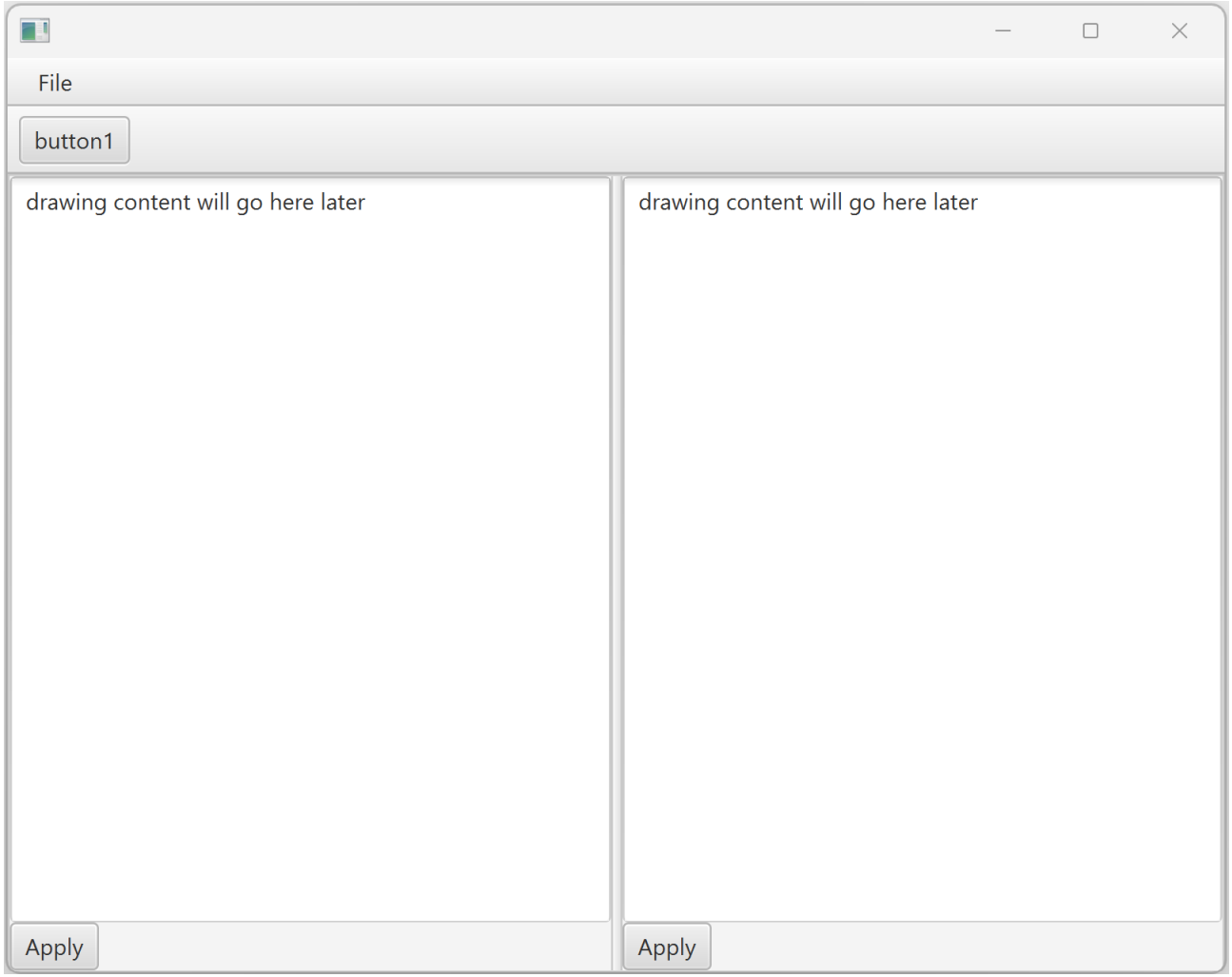
```
model = new Model()

view1 = new TextDrawingView1(model)
view2 = new TextDrawingView1(model)

add views
```

Step 3 code

```
{ // SplitPane( view1 | view2 )
    VBox view1 = new VBox();
    view1.getChildren().add(new Text("Hello 1"));

    VBox view2 = new VBox();
    view2.getChildren().add(new Text("Hello 2"));

    SplitPane splitViewPane = new SplitPane(view1, view2);
    mainBorderPanel.setCenter(splitViewPane);
}

Scene scene = new Scene(mainBorderPanel, 640, 480);
stage.setScene(scene);
stage.show();
}
```

```
DrawingDocModel model = new DrawingDocModel();
model.setContent("drawing content will go here later");

{ // SplitPane( view1 | view2 )
    TextDrawingView view1 = new TextDrawingView(model);
    Node view1Comp = view1.getComponent();

    TextDrawingView view2 = new TextDrawingView(model);
    Node view2Comp = view2.getComponent();

SplitPane splitViewPane = new SplitPane(view1Comp, view2Comp);
mainBorderPanel.setCenter(splitViewPane);
}
```

Step 3 Expected Result

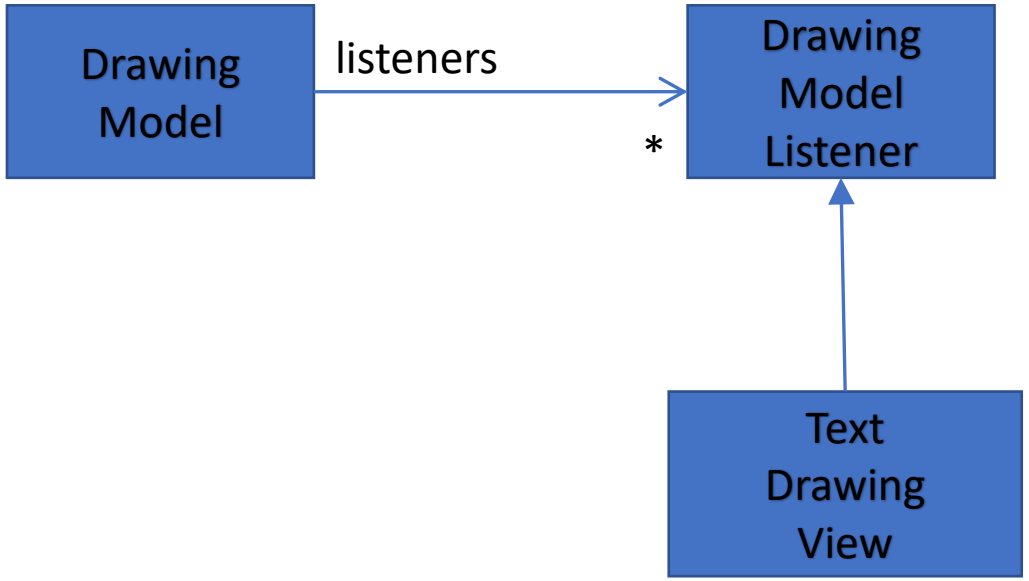


Step 4 : Publish & Subscribe Design Pattern

Declare « interface DrawingModelListener »

Add on model-side
« List< DrawingModelListener> listeners = new ArrayList<>(); »
methods addListener / removeListener / fireListenerChange()

Add « implements DrawingModelListener » on view-side + model.addListener(this)



Step 4 code (1/3)

```java
protected List<DrawingModelListener> listeners = new ArrayList<>();

public void setContent(String content) {
  this.content = content;
  fireModelChange();
}

public void addListener(DrawingModelListener p) {
  this.listeners.add(p);
}
public void removeListener(DrawingModelListener p) {
  this.listeners.remove(p);
}

protected void fireModelChange() {
  for(DrawingModelListener listener : listeners) {
    listener.onModelChange();
  }
}
```

```java
public interface DrawingModelListener {
   public void onModelChange();
}
```

Step 4 : Code (2/3)

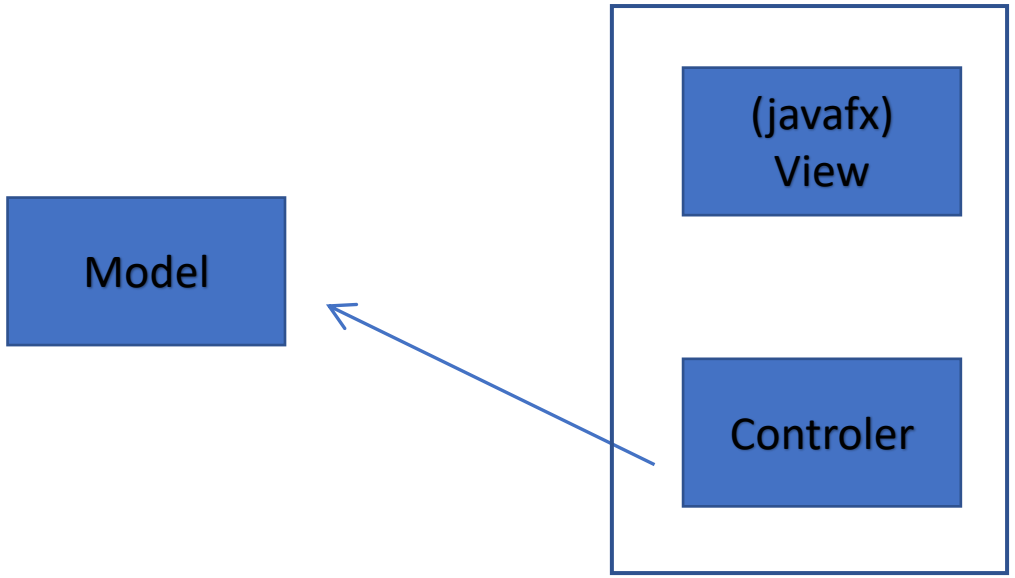
```
public class TextDrawingView extends DrawingView implements DrawingModelListener {

    public TextDrawingView(DrawingDocModel model) {

      model.addListener(this); // publish&subscribe design pattern
    }

    protected void refreshModelToView() {
      String text = model.getContent();
      textArea.setText(text);
    }

    @Override
    public void onModelChange() {
      System.out.println("(from subscribe): model to view change");
      refreshModelToView();
    }
```

Step 4 : Alternative Code (3/3)
… do not expose « public » Listener

```
public class TextDrawingView extends DrawingView {

  protected DrawingModelListener innerListener = new DrawingModelListener() {
    @Override
    public void onModelChange() {
      System.out.println("(from subscribe): model to view change");
      refreshModelToView();
    }
  };

  public TextDrawingView(DrawingDocModel model) {
      …
      model.addListener(this.innerListener); // publish&subscribe design pattern
  }

  protected void refreshModelToView() {
    String text = model.getContent();
    textArea.setText(text);
  }
```

Step 5 : MVC… C=Controller

User-defined « View » class = javafx View + Controller



button.setOnAction(e -> onClickApply());

Javafx.control.Button

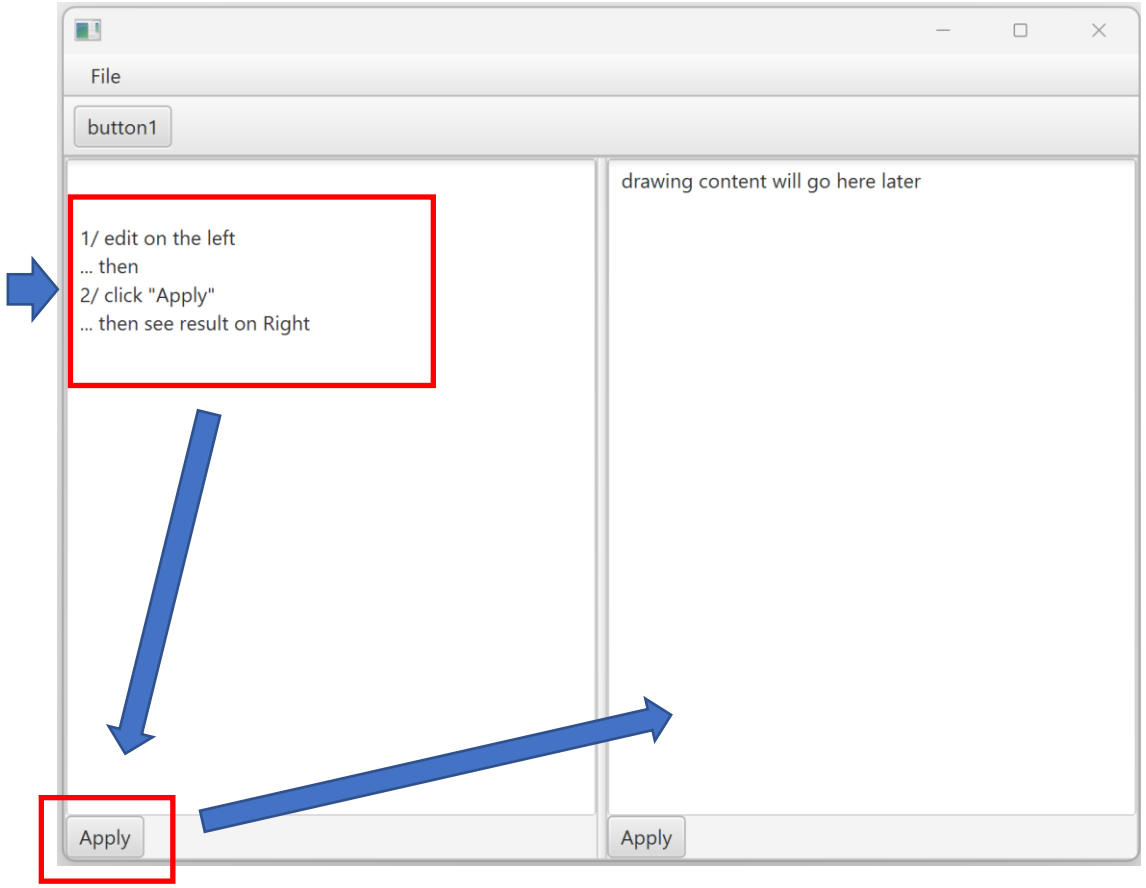
On Click button

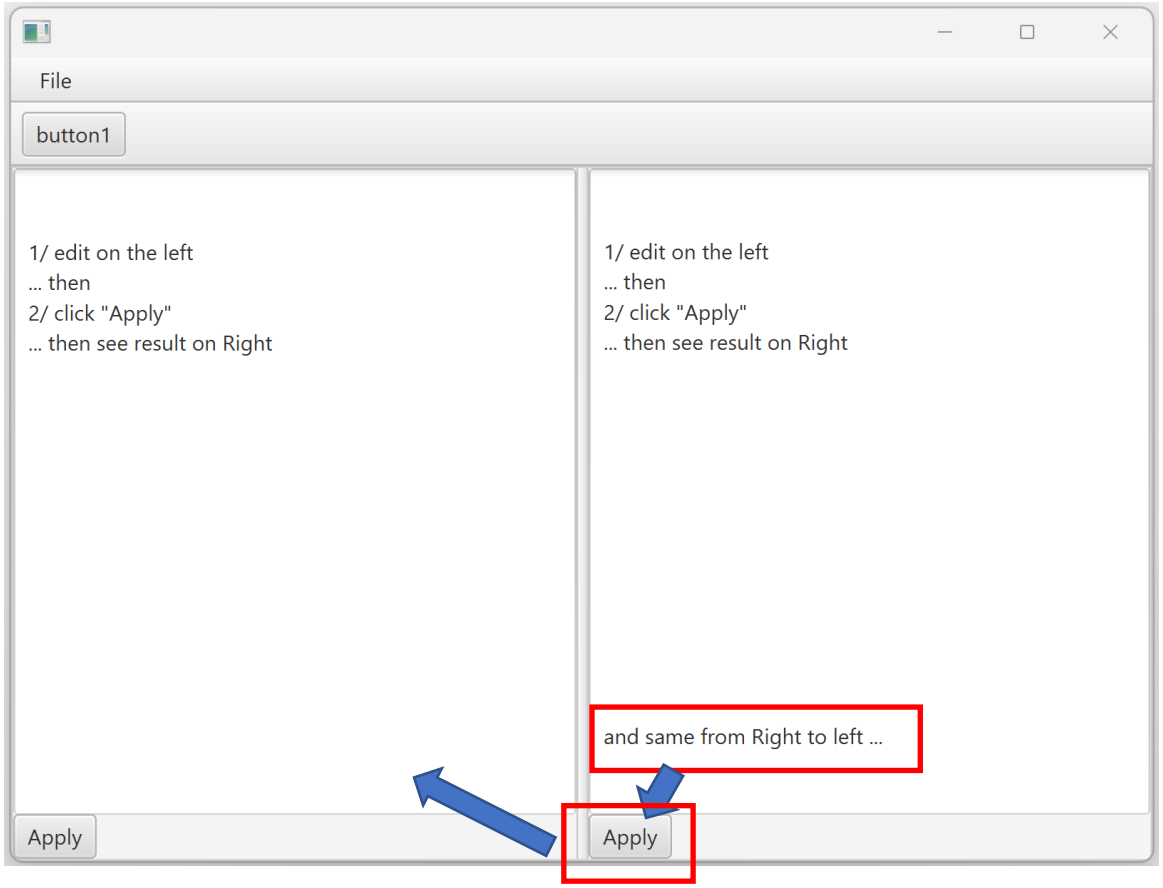
```
onClickApply()  {
    // view to model update
}
```

Step 5: code

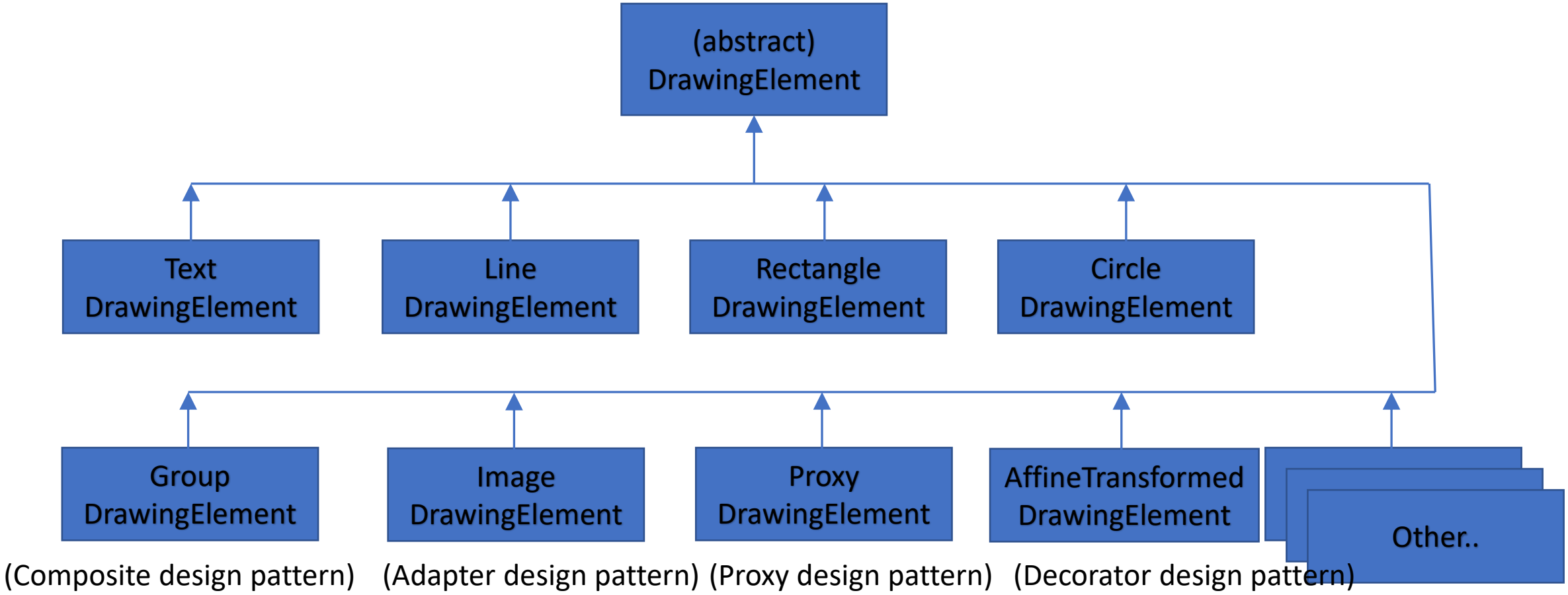
```
public TextDrawingView(DrawingDocModel model) {
  …
  this.applyButton = new Button("Apply");
  applyButton.setOnAction(e -> onClickApply());
}


private void onClickApply() {
  System.out.println("apply view to model update");
  String text = textArea.getText();
  model.setContent(text); // => fireModelChange ..
}
```

Step 5 : Expected Result





Step 6 : core domain classes
design pattern… AST class hierarchy, Interpreter



Step 6: code (1/4)

```
/**
 * abstract base class for Drawing element
 * AST class hierarchy
 * see sub-classes:
 * <ul>
 * <li> TextDrawingElement </li>
 * <li> LineDrawingElement </li>
 * <li> RectanleDrawingElement </li>
 * <li> CircleDrawingElement </li>
 * <li> ImageDrawingElement (adapter design pattern, to image: png/jpg/gif/.. )</li>
 * <li> GroupDrawingElement (composite design-pattern) </li>
 * <li> other.. </li>
 * </ul>
 */
public abstract class DrawingElement {

  // nothing except
  // TOADD: visitor design pattern
}
```

Step 6 : code(2/4)

```java
public class DrawingPt {

  public double x;
  public double y;

  public DrawingPt() {
  }

  public DrawingPt(
      double x,
      double y) {
    this.x = x;
    this.y = y;
  }

}
```

```java
public class BaseDrawingElements {

  public static class TextDrawingElement extends DrawingElement {
    public String text;
    public DrawingPt pos;
    public Map<String,Object> properties; // font, size, color,
  }
  public static class LineDrawingElement extends DrawingElement {
    public DrawingPt start;
    public DrawingPt end;
    public Map<String,Object> properties; // width, stroke, color, ..
  }
  public static class RectangleDrawingElement extends DrawingElement {
    public DrawingPt upLeft;
    public DrawingPt downRight;
    public Map<String,Object> properties; // width, stroke, color, ..
  }
  public static class CircleDrawingElement extends DrawingElement {
    public DrawingPt center;
    public double radius;
    public Map<String,Object> properties; // width, stroke, color, ..
  }
}
```

Step 6 code (3/4)

```
/**
 * Composite design pattern
 */
public static class GroupDrawingElement extends DrawingElement {
  public List<DrawingElement> elements = new ArrayList<>();
}

/**
 * Adapter design pattern, for javafx.scene.image.Image
 */
public static class ImageDrawingElement extends DrawingElement {
  public javafx.scene.image.Image image; // => url, mimeType, data
}
```

Step 6 code (4/4)

```
/**
 * Proxy design pattern
 * example: including part from another document
 */
public static class ProxyDrawingElement extends DrawingElement {
  public DrawingElement underlying;
}

/**
 * Decorator design pattern
 * For geometrical affine transformation
 */
public static class AffineTransformedDrawingElement extends DrawingElement {
  public DrawingElement underlying;
  public DrawingPt translate;
  public double rotateAngle;
  public double scale;
}
```

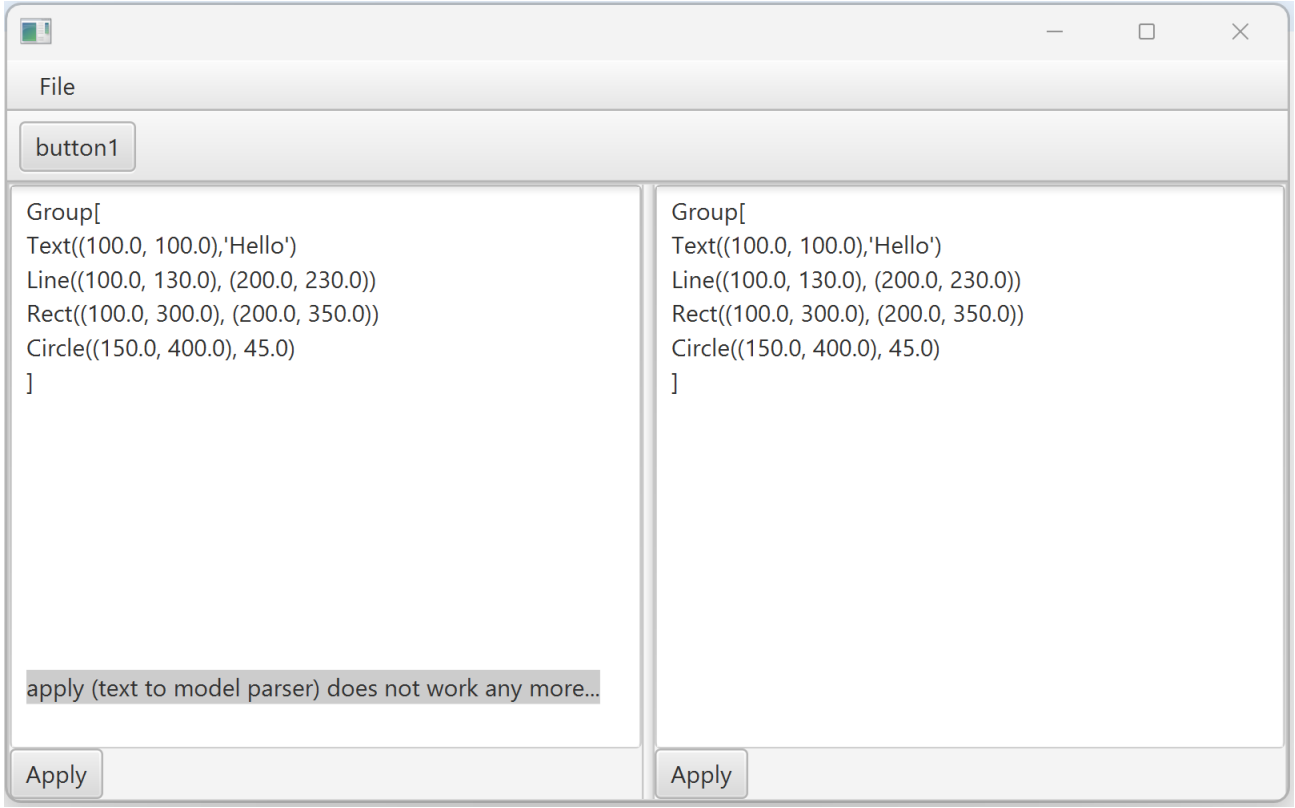
Step 7 : instanciate a simple Drawing
Text + Line + Rectangle + Circle

```
public GroupDrawingElement createSimpleDrawing() {
    TextDrawingElement text = new TextDrawingElement("Hello", new DrawingPt(100, 100));

    LineDrawingElement line = new LineDrawingElement(new DrawingPt(100, 130),
                                                     new DrawingPt(200, 230));

    RectangleDrawingElement rectangle = new RectangleDrawingElement(
                                            new DrawingPt(100, 300), new DrawingPt(200, 350));

    CircleDrawingElement circle = new CircleDrawingElement(new DrawingPt(150, 400), 45);

    GroupDrawingElement res = new GroupDrawingElement();
    res.addAll(text, line, rectangle, circle);
    return res;
}
```

Step 8 : change Model-> to use DrawingElement + naive code for model to text (cf next … using Visitor)

```
public class DrawingDocModel {
  protected String documentName;
  protected DrawingElement content;  // was String before step8


// in main:
DrawingDocModel model = new DrawingDocModel();
DrawingElement content = createSimpleDrawing();
model.setContent(content);
```

Step 8 : expected Result



Step 8 : code (1/3)

```
protected void refreshModelToView() {
   DrawingElement content = model.getContent();
   String text = recursiveElementToText(content);
   textArea.setText(text);
}

private String recursiveElementToText(DrawingElement drawingElement) {
  if (drawingElement instanceof TextDrawingElement) {
    TextDrawingElement p = (TextDrawingElement) drawingElement;
    return "Text(" + p.pos + ",'" + p.text + "')";
  } else if (drawingElement instanceof LineDrawingElement) {
    LineDrawingElement p = (LineDrawingElement) drawingElement;
    return "Line(" + p.start + ", " + p.end + ")";

  // } else .. Cf next page
```

Step 8 code (2/3)

```
  } else if (drawingElement instanceof RectangleDrawingElement) {
    RectangleDrawingElement p = (RectangleDrawingElement) drawingElement;
    return "Rect(" + p.upLeft + ", " + p.downRight + ")";
  } else if (drawingElement instanceof CircleDrawingElement) {
    CircleDrawingElement p = (CircleDrawingElement) drawingElement;
    return "Circle(" + p.center + ", " + p.radius + ")";
  } else if (drawingElement instanceof GroupDrawingElement) {
    GroupDrawingElement p = (GroupDrawingElement) drawingElement;
    StringBuilder sb = new StringBuilder();
    sb.append("Group[\n");
    for(DrawingElement child: p.elements) {
      // *** recurse ***
      sb.append(recursiveElementToText(child));
      sb.append("\n");
    }
    sb.append("]");
    return sb.toString();
  } else {
    return "not implemented/recognized drawingElement "+
      drawingElement.getClass().getName();
  }
}
```

Step 9: introduce the Visitor design-pattern

instead of ugly « if (instanceof ..) downcast ..else »

Step 9 : code (1/2)

```java
public abstract class DrawingElementVisitor {

  public abstract void caseText(TextDrawingElement p);
  public abstract void caseLine(LineDrawingElement p);
  public abstract void caseRect(RectangleDrawingElement p);
  public abstract void caseCircle(CircleDrawingElement p);
  public abstract void caseGroup(GroupDrawingElement p);

  public abstract void caseOther(DrawingElement p);
}
```

```java
public abstract class DrawingElement {
  /**
   * Visitor design pattern
   * implement in sub-class, to call <code> visitor.caseXX(this); </code>
   */
  public abstract void accept(DrawingElementVisitor visitor);
}
```

Step 9 : code (2/2)

```
class TextDrawingElement ...
  @Override
  public void accept(DrawingElementVisitor visitor) {
    visitor.caseText(this);
  }
}

class LineDrawingElement ...
  @Override
  public void accept(DrawingElementVisitor visitor) {
    visitor.caseLine(this);
  }
}

... class <<XX>>DrawingElement ...
 @Override
  public void accept(DrawingElementVisitor visitor) {
     visitor.case<<XX>>(this);
  }
```

Step 10 : refactor «String recursiveElementToText(DrawingElement e) » to use Visitor design-pattern

Step 10 : code (1/2)

```
private String recursiveElementToText(DrawingElement drawingElement) {
  TextDrawingElementVisitor visitor = new TextDrawingElementVisitor();
  drawingElement.accept(visitor);
  return visitor.result;
}

protected static class TextDrawingElementVisitor extends DrawingElementVisitor {

  String result;

  @Override
  public void caseText(TextDrawingElement p) {
    result = "Text(" + p.pos + ",'" + p.text + "')";
  }

  @Override
  public void caseLine(LineDrawingElement p) {
    result = "Line(" + p.start + ", " + p.end + ")";
  }
```

Step 10 : code (2/2)

```java
@Override
public void caseRect(RectangleDrawingElement p) {
  result = "Rect(" + p.upLeft + ", " + p.downRight + ")";
}
@Override
public void caseCircle(CircleDrawingElement p) {
  result = "Circle(" + p.center + ", " + p.radius + ")";
}
@Override
public void caseGroup(GroupDrawingElement p) {
  StringBuilder sb = new StringBuilder();
  sb.append("Group[\n");
  for(DrawingElement child: p.elements) {
    // *** recurse ***
    child.accept(this);
    sb.append(result);
    sb.append("\n");
  }
  sb.append("]");
  result = sb.toString();
}
```

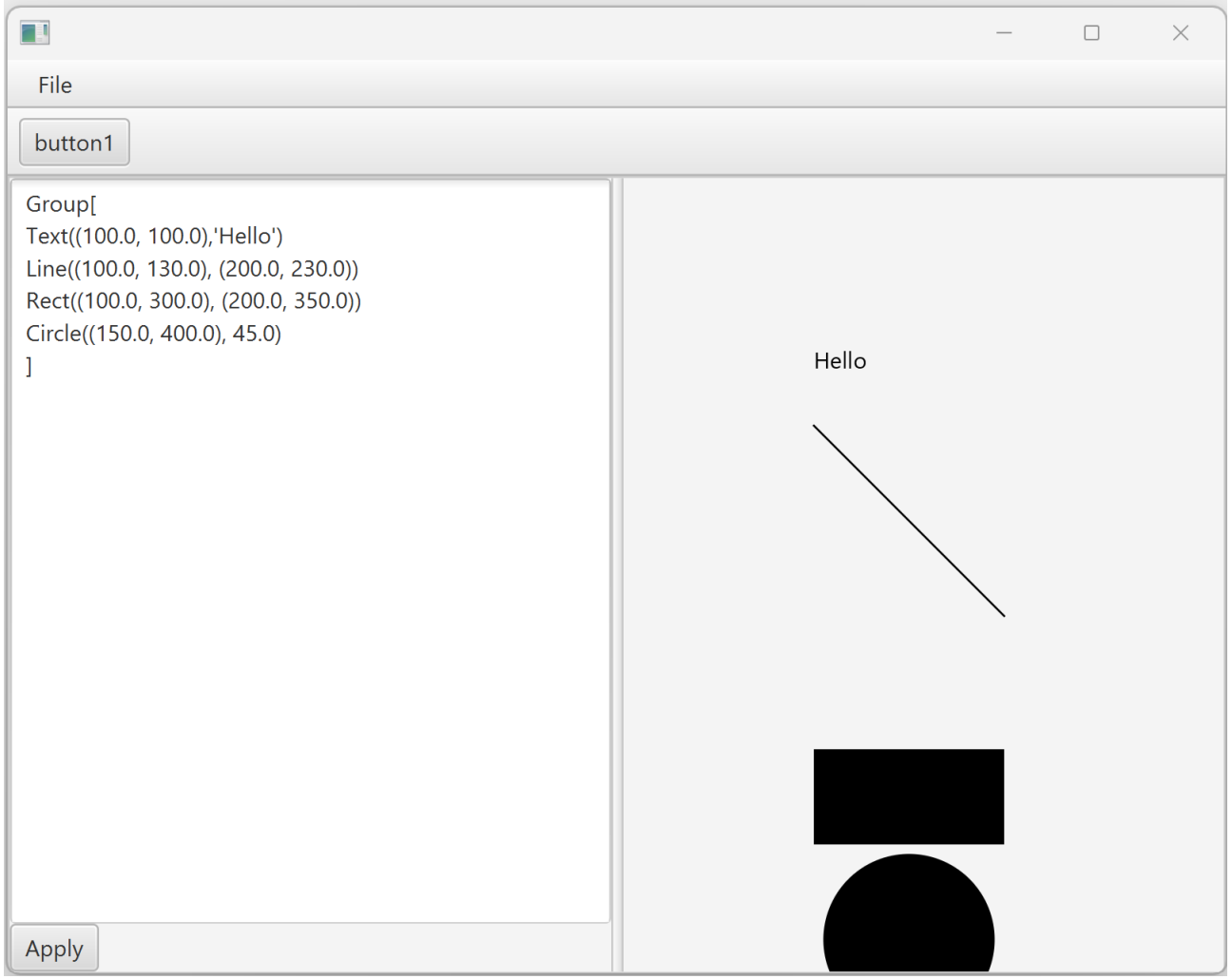
```java
@Override
public void caseOther(DrawingElement p) {
  result = "not implemented/recognized
drawingElement " + p.getClass().getName();
}
```

Step 11 : implement a graphical DrawingElementView sub-class (copy&paste from TextDrawingView)

using javafx shape objects

use in application right View (keep left as Text)

Step 11 : expected Result



Step 11 : code (1/3)

```
{ // SplitPane( view1 | view2 )
  TextDrawingView view1 = new TextDrawingView(model);
  Node view1Comp = view1.getComponent();

  CanvasDrawingView view2 = new CanvasDrawingView(model);
  Node view2Comp = view2.getComponent();

  SplitPane splitViewPane = new SplitPane(view1Comp, view2Comp);
  mainBorderPanel.setCenter(splitViewPane);
}
```

```
public class CanvasDrawingView extends DrawingView {

  protected BorderPane component;
  // to add javafx.scene.shape.* objects converted from model
  protected Pane drawingPane;
```

Step 11 : code (2/3)

```
protected void refreshModelToView() {
  DrawingElement content = model.getContent();
  drawingPane.getChildren().clear();
  JavafxDrawingElementVisitor visitor = new JavafxDrawingElementVisitor();
  content.accept(visitor);
}

protected class JavafxDrawingElementVisitor extends DrawingElementVisitor {
  protected void add(Node node) {
    drawingPane.getChildren().add(node);
  }
  @Override
  public void caseText(TextDrawingElement p) {
    add(new javafx.scene.text.Text(p.pos.x, p.pos.y, p.text));
  }
  @Override
  public void caseLine(LineDrawingElement p) {
    add(new new javafx.scene.shape.Line(p.start.x, p.start.y, p.end.x, p.end.y));
  }
```

Step 11 : code (3/3)

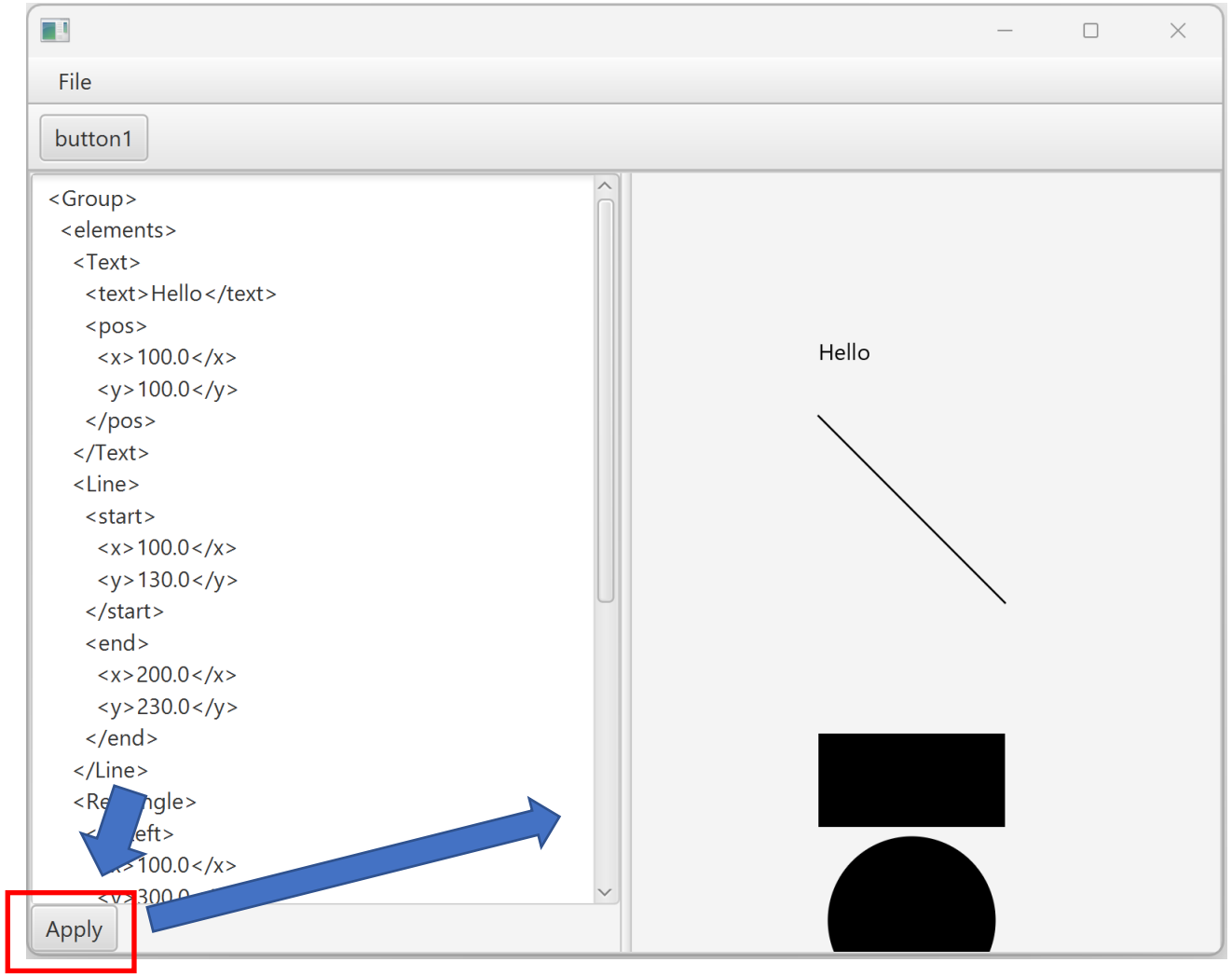
```
@Override
public void caseRect(RectangleDrawingElement p) {
  add(new javafx.scene.shape.Rectangle(p.upLeft.x, p.upLeft.y,
              p.downRight.x-p.upLeft.x, p.downRight.y-p.upLeft.y);
}
@Override
public void caseCircle(CircleDrawingElement p) {
  add(new javafx.scene.shape.Circle(p.center.x, p.center.y, p.radius);
}
@Override
public void caseGroup(GroupDrawingElement p) {
  for(DrawingElement child: p.elements) {
    // *** recurse ***
    child.accept(this);
  }
}
@Override
public void caseOther(DrawingElement p) {
  // "not implemented/recognized drawingElement "+ p.getClass().getName();
}
```

Step 12 : recover Full Edit capabilities

… using XStream library

for formatting model -> text (xml)
and parsing text (xml) -> model

Step 12 : expected result



Step 12 : code (1/3)

```
<dependency>
  <groupId>com.thoughtworks.xstream</groupId>
  <artifactId>xstream</artifactId>
  <version>1.4.20</version>
</dependency>
```

Step 12 : code (2/3)

```
XStream xstream = createXStream();

static XStream createXStream() {
  XStream xstream = new XStream();
  xstream.addPermission(AnyTypePermission.ANY);

  xstream.alias("Pt", DrawingPt.class);
  xstream.alias("Text", TextDrawingElement.class);
  xstream.alias("Line", LineDrawingElement.class);
  xstream.alias("Circle", CircleDrawingElement.class);
  xstream.alias("Rectangle", RectangleDrawingElement.class);
  xstream.alias("Group", GroupDrawingElement.class);
  return xstream;
}
```

Step 12 : code (3/3)

```
protected void refreshModelToView() {
  DrawingElement content = model.getContent();
  String text = xstream.toXML(content);
  textArea.setText(text);
}

private void onClickApply() {
  System.out.println("apply view to model update");
  String text = textArea.getText();
  DrawingElement content =  (DrawingElement) xstream.fromXML(text);
  model.setContent(content); // => fireModelChange ..
}
```

Step 13 : Add Button Toolbar for editing new « Line »

```
{ // button Toolbar
    ToolBar toolBar = new ToolBar();
    component.setTop(toolBar);

    Button resetToolButton = new Button("Reset");
    resetToolButton.setOnAction(e -> onClickToolReset());
    toolBar.getItems().add(resetToolButton);

    Button newLineButton = new Button("+Line");
    newLineButton.setOnAction(e -> onClickToolNewLine());
    toolBar.getItems().add(newLineButton);
    }
```

Step 14 : Tool State Handler

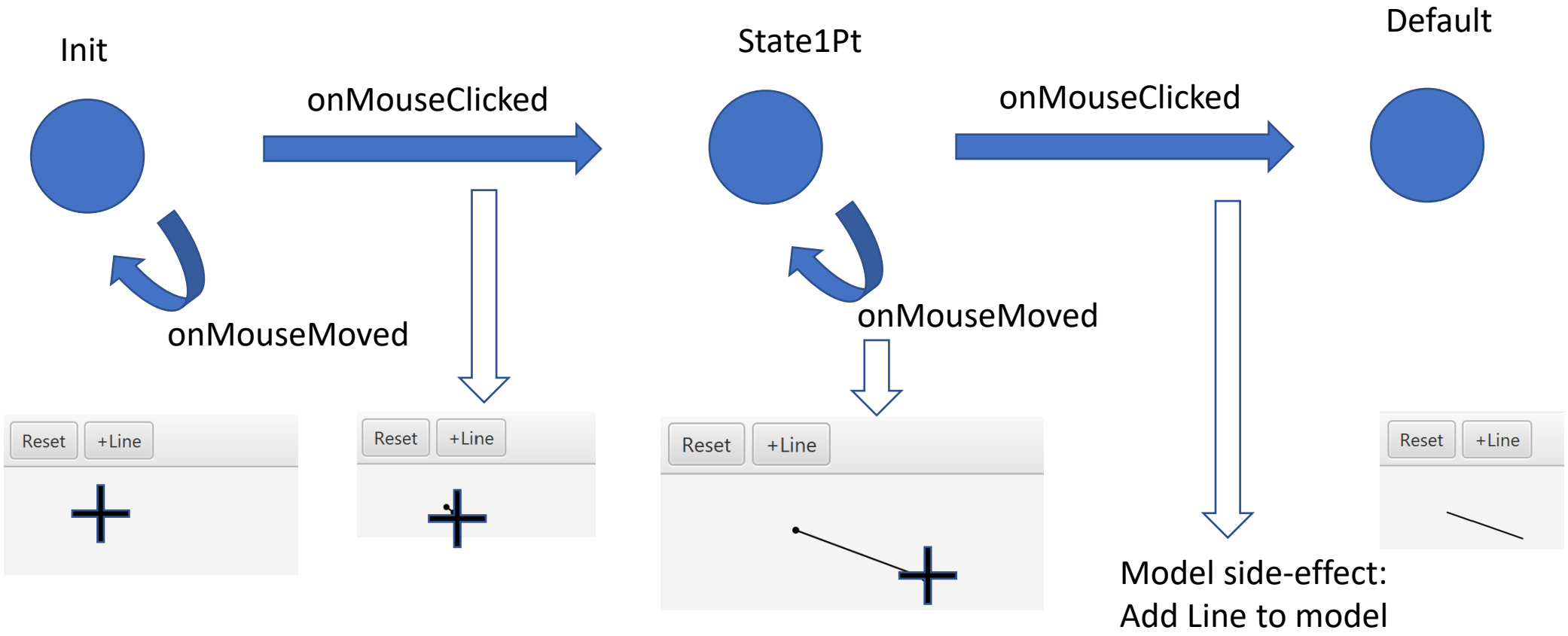
```java
public abstract class ToolStateHandler {

  public abstract void onMouseEntered();
  public abstract void onMouseMove(MouseEvent event);
  public abstract void onMouseClick(MouseEvent event);

}
```

```java
drawingPane.setOnMouseEntered(e -> currToolStateHandler.onMouseEnter());
drawingPane.setOnMouseMoved(e -> currToolStateHandler.onMouseMoved(e));
drawingPane.setOnMouseClicked(e -> currToolStateHandler.onMouseClicked(e));
```

Step 14

```
protected class DefaultSelectToolStateHandler extends DefaultToolStateHandler {

  @Override
  public void onMouseEnter() {
    drawingPane.setCursor(Cursor.DEFAULT);
  }

}
```

Step 15 : State Automaton for « new Line »



Step 15: code

```
protected ToolStateHandler currToolStateHandler = new DefaultSelectToolStateHandler();

protected ObservableList<Node> currToolShapes = FXCollections.observableArrayList();
protected CircleDrawingElement currEditLineStartPt;
protected CircleDrawingElement currEditLineEndPt;
protected LineDrawingElement currEditLine;


protected void updateCurrEditTool() {
  drawingPane.getChildren().removeAll(currToolShapes);
  currToolShapes.clear();
  JavafxDrawingElementVisitor visitor = new JavafxDrawingElementVisitor(currToolShapes);
  if (currEditLineStartPt != null) { currEditLineStartPt.accept(visitor); }
  if (currEditLineEndPt != null) { currEditLineEndPt.accept(visitor); }
  if (currEditLine != null) { currEditLine.accept(visitor); }
  drawingPane.getChildren().addAll(currToolShapes);
}
```

Step 15

```
private void onClickToolReset() {
  this.currToolStateHandler = new DefaultToolStateHandler();
  currEditLineStartPt = null;
  currEditLineEndPt = null;
  currEditLine = null;
  refreshModelToView();
}
private void onClickToolNewLine() {
  this.currToolStateHandler = new StateInit_LineToolStateHandler();
}

protected void setToolHandler(ToolStateHandler p) {
  currToolStateHandler = p;
  updateCurrEditTool();
}
```

Step 15

```
protected class StateInit_LineToolStateHandler extends DefaultToolStateHandler {

@Override
public void onMouseEnter() {
  drawingPane.setCursor(Cursor.CROSSHAIR);
}

@Override
public void onMouseClicked(MouseEvent event) {
  double x = event.getX(), y = event.getY();
  DrawingPt pt = new DrawingPt(x, y);
  currEditLineStartPt = new CircleDrawingElement(pt, 2);
  currEditLineEndPt = new CircleDrawingElement(pt, 2);
  currEditLine = new LineDrawingElement(pt, pt);
  updateCurrEditTool();
  setToolHandler(new StatePt1_LineToolStateHandler());
}
```

Step 15

```
protected class StatePt1_LineToolStateHandler extends DefaultToolStateHandler {
  @Override
  public void onMouseEnter() {
    drawingPane.setCursor(Cursor.CROSSHAIR);
  }
  @Override
  public void onMouseMoved(MouseEvent event) {
    double x = event.getX(), y = event.getY();
    currEditLineEndPt.center = currEditLine.end = new DrawingPt(x, y);
    updateCurrEditTool();
  }
  @Override
  public void onMouseClicked(MouseEvent event) {
    LineDrawingElement addToModel = currEditLine;
    GroupDrawingElement content = (GroupDrawingElement) model.getContent();
    content.elements.add(addToModel);
    model.setContent(content);
    currEditLine = null; currEditLineStartPt = null; currEditLineEndPt = null;
    updateCurrEditTool();
    setToolHandler(new DefaultSelectToolStateHandler());
}
```

..

..

..

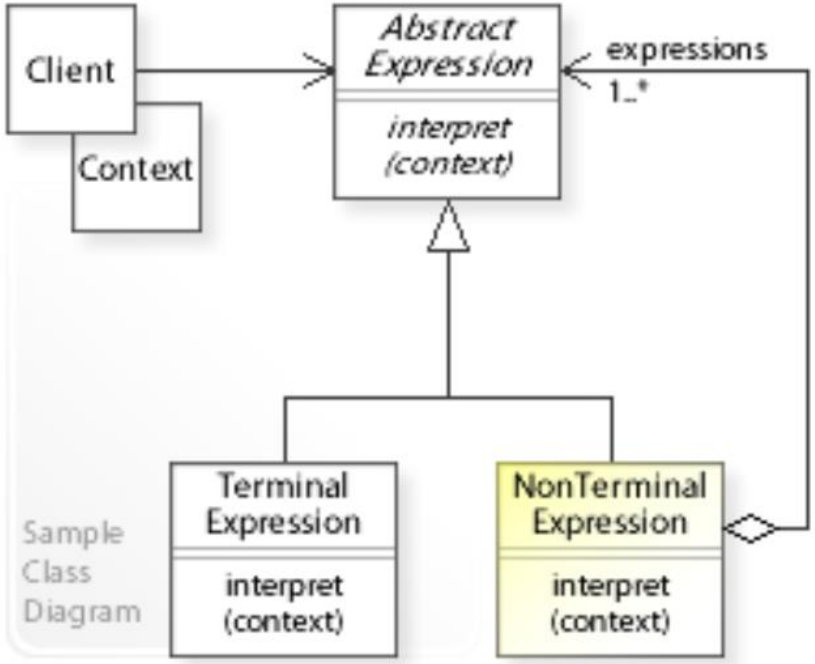
ANNEXE

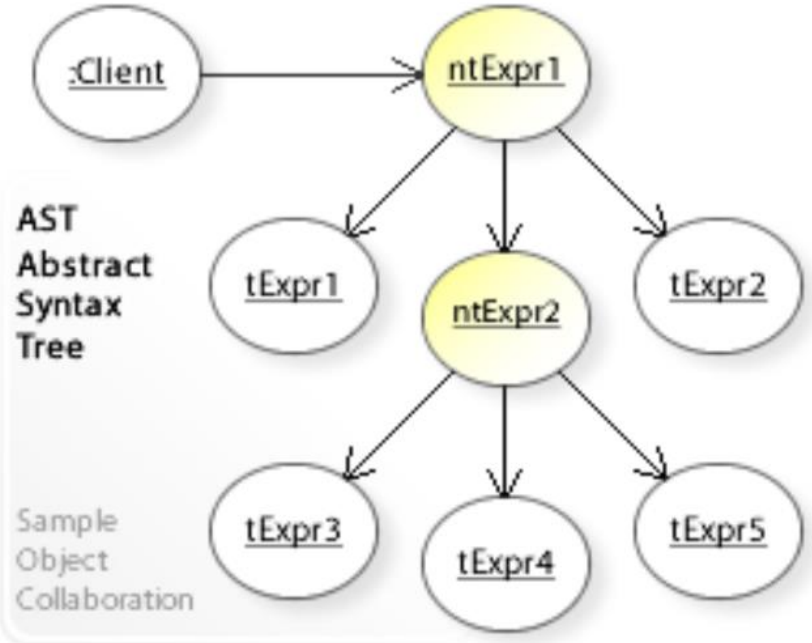
Using « Expression » instead of « Double » … advanced feature

Interpreter

REMINDER

Given a language, define a representation for its grammar along with an interpreter that uses the representation to interpret sentences in the language.





Example of Interpreter : Math Expression

```
expression ::= plus | minus | variable | number
plus ::= expression expression '+'
minus ::= expression expression '-'
variable ::= 'a' | 'b' | 'c' | ... | 'z'
digit = '0' | '1' | ... | '9'
number ::= digit | digit number
```

REMINDER

```
abstract class Expression {}

class NumberExpression extends Expression {
    double value;
}


class VariableExpression extends Expression {
    String name;
}

class BinaryOperationExpression extends Expression {
  Expression leftOperand;
  String operator;
  Expression rightOperand;
}
```

Example, using JEP library

ANNEXE

```
<dependency>
    <groupId>org.scijava</groupId>
    <artifactId>jep</artifactId>
    <version>2.4.2</version>
</dependency>
```

```
JEP jep = new JEP();

jep.addVariable("x", 123);

Node expr = jep.parseExpression("x+2");

Double eval = (Double) jep.evaluate(expr);

System.out.println("x=123,  x+2 => " + eval);
```

Reminder … « Bridge » design-pattern

ANNEXE

```
public class DrawingExprContext {

  protected Map<String,Object> values;
  protected org.nfunk.jep.JEP internalImpl;
..


public class DrawingExpr {

  protected String text;
  protected org.nfunk.jep.Node internalImpl;
..
```