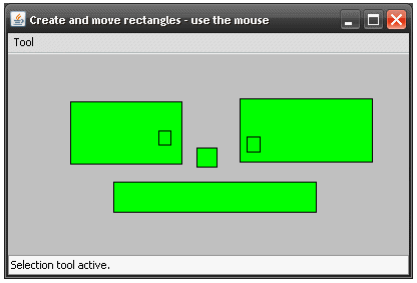
MiniDraw

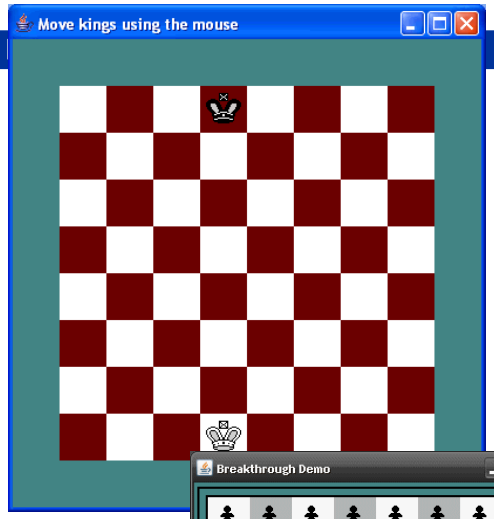
Introducing a Framework

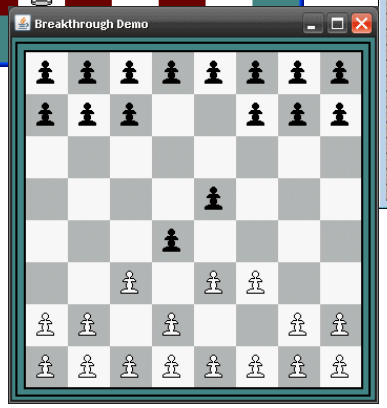
... and a few patterns

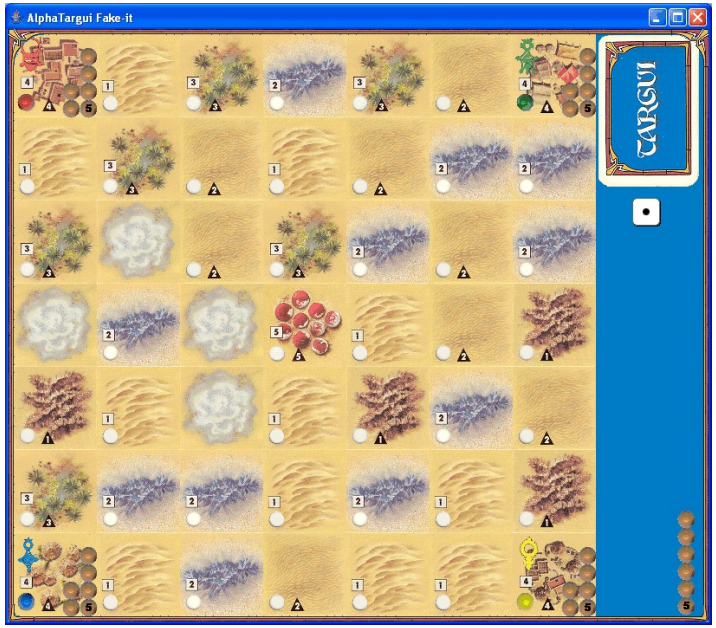
What is it?

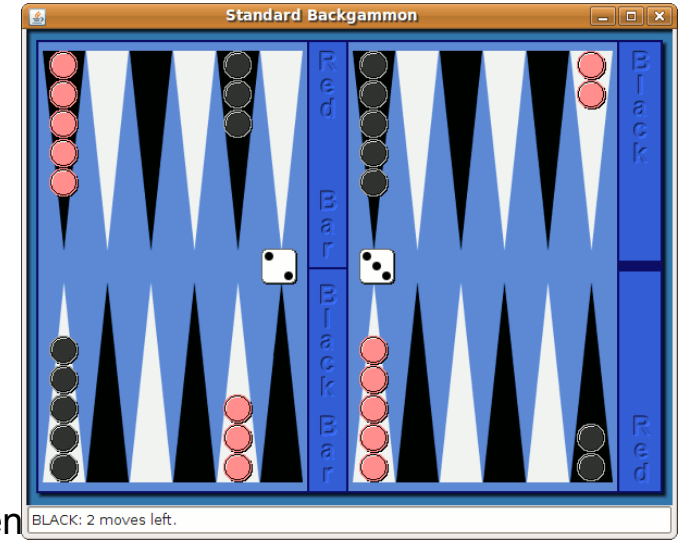
[Demo]











What do I get?

MiniDraw helps you building apps that have

- 2D image based graphics
  - GIF files
  - Optimized repainting
- Direct manipulation
  - Manipulate objects directly using the mouse
- Semantic constraints
  - Keep objects semantically linked

History

MiniDraw is downsized from JHotDraw

JHotDraw

- Thomas Eggenschwiler and Erich Gamma
- Java version of HotDraw

HotDraw

- Kent Beck and Ward Cunningham.
- Part of a smalltalk research project that lead to the ideas we now call *design patterns* and *frameworks*

MiniDraw

MiniDraw

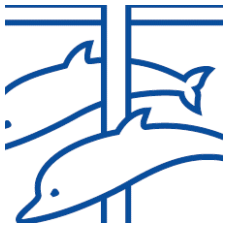
- supporting board games mainly
- cut down detail for teaching purposes
- one day convert to C# (hmm ?)
- MiniDraw: compositional design (most of the time)
- JHotDraw: polymorphic design (quite a lot of the time)

Newest addition

- BoardGame extension:
  - High support for board games

Our first MiniDraw application

- DrawingEditor
  - "Project manager"/Redaktør
  - Default implementation
- Figure
  - Visible element
  - ImageFigure
- Drawing
  - container of figures
- Tool
  - = controller
- Factory
  - create impl. of MiniDraw roles
- DrawingView
  - view type to use...



```
public class LogoPuzzle {

  public static void main(String[] args) {
    DrawingEditor editor =
      new MiniDrawApplication( "Put the pieces into place",
                               new PuzzleFactory() );
    editor.open();
    editor.setTool( new SelectionTool(editor) );

    Drawing drawing = editor.drawing();
    drawing.add(  new ImageFigure( "11", new Point(5, 5)) );
    drawing.add(  new ImageFigure( "12", new Point(10, 10)) );
    drawing.add(  new ImageFigure( "13", new Point(15, 15)) );
    drawing.add(  new ImageFigure( "21", new Point(20, 20)) );
    drawing.add(  new ImageFigure( "22", new Point(25, 25)) );
    drawing.add(  new ImageFigure( "23", new Point(30, 30)) );
    drawing.add(  new ImageFigure( "31", new Point(35, 35)) );
    drawing.add(  new ImageFigure( "32", new Point(40, 40)) );
    drawing.add(  new ImageFigure( "33", new Point(45, 45)) );
  }
}

class PuzzleFactory implements Factory {
  public DrawingView createDrawingView( DrawingEditor editor ) {
    DrawingView view =
      new StdViewWithBackground(editor, "au-seal-large");
    return view;
  }

  public Drawing createDrawing( DrawingEditor editor ) {
    return new StandardDrawing();
  }

  public JTextField createStatusField( DrawingEditor editor ) {
    return null;
  }
}
```

The Patterns in MiniDraw

Not *what* but *why*?

The 3-1-2 principles in action again...

MiniDraw software architecture

Main JHotDraw architecture remains

- **Model-View-Controller** architectural pattern
  - Drawing-DrawingView-Tool
- **Observer** pattern event mechanism

MVC' problem statement

Challenge:

- writing programs with a graphical user interface
- multiple open windows showing the same data – keeping them consistent

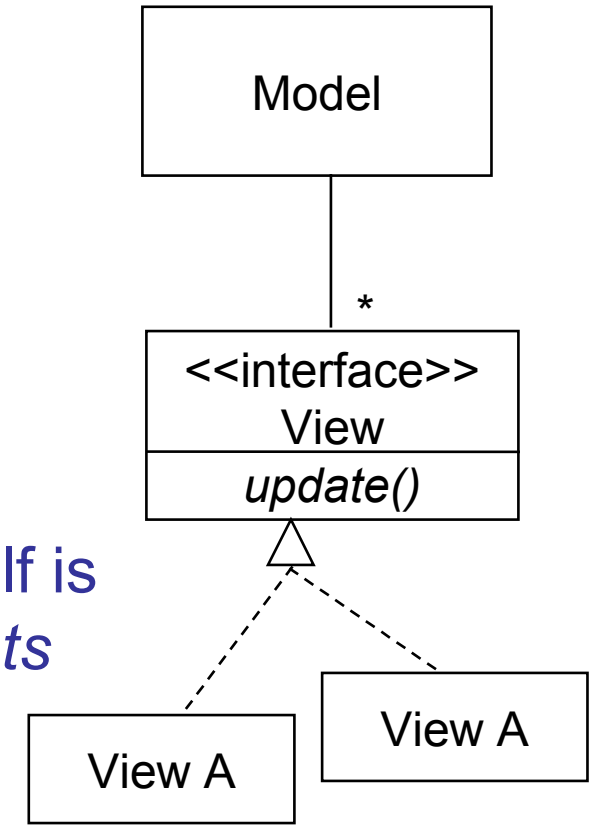
- manipulating data in many different ways by direct manipulation (eg. move, resize, delete, create, ...)
  - i.e. switching *tool* will switch the object manipulation

Challenge 1

Keeping multiple windows consistent?

Analysis:

- **Data** is shared but **visualization** is variable!



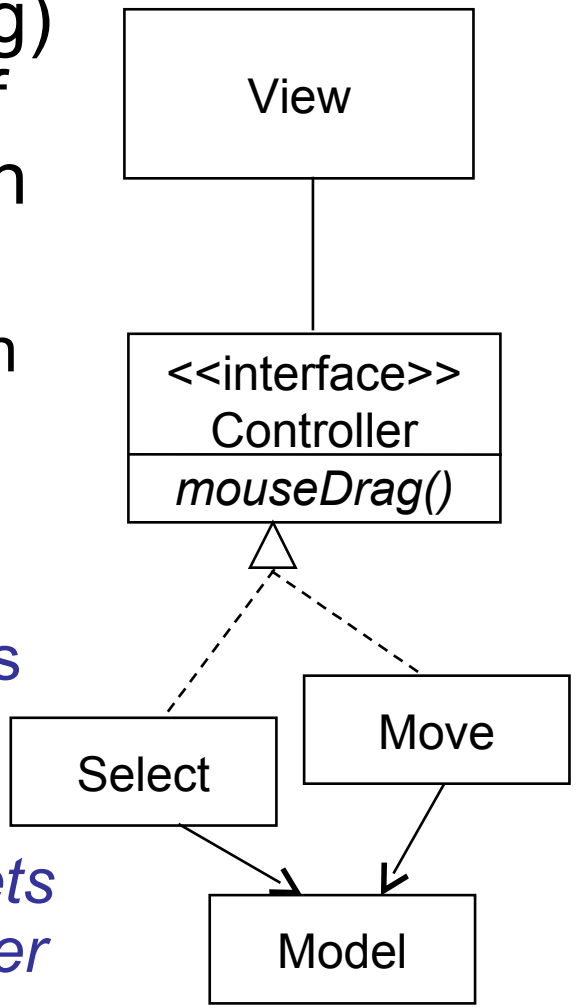
- ③ Data **visualisation** is variable behaviour
- ① Responsibility to visualize data is expressed in interface: *View*
- ② Instead of data object (model) itself is responsible for drawing graphics it *lets someone else do the job: the views*

Challenge 2

Few mouse events (down, up, drag) translate to open-ended number of actions (move, resize, create, ?) on data.

- Events are the same but manipulation is variable

- ③ Data **manipulation** is variable behaviour
- ① Responsibility to manipulate data is expressed in interface: *Controller*
- ② Instead of graphical view itself is responsible for manipulating data it *lets someone else do the job: the controller*



Observer

Challenge 1:

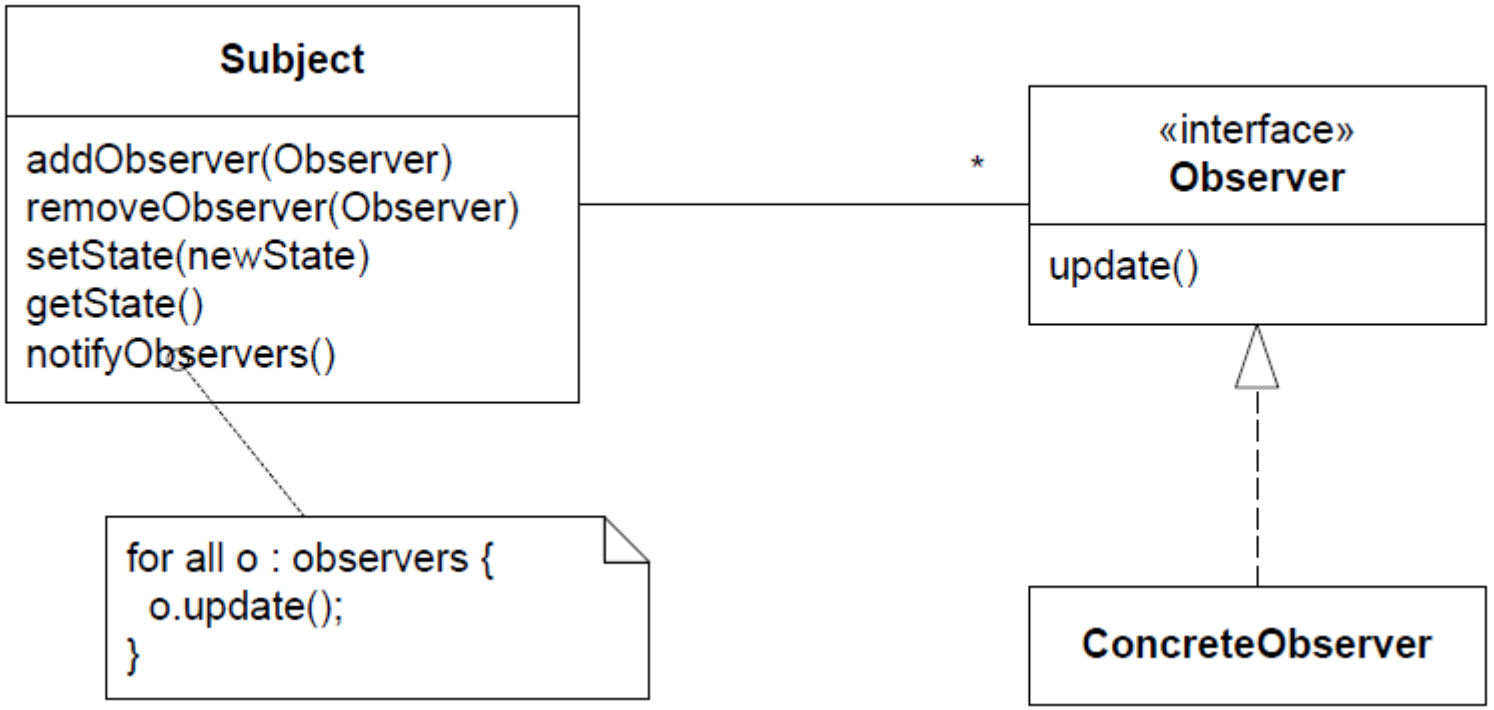
- Also known as ***observer*** *pattern*

Intent

- *Define a one-to-many dependency between objects so that when one object changes state, all its dependents are notified and updated automatically*.

Observer: Structure

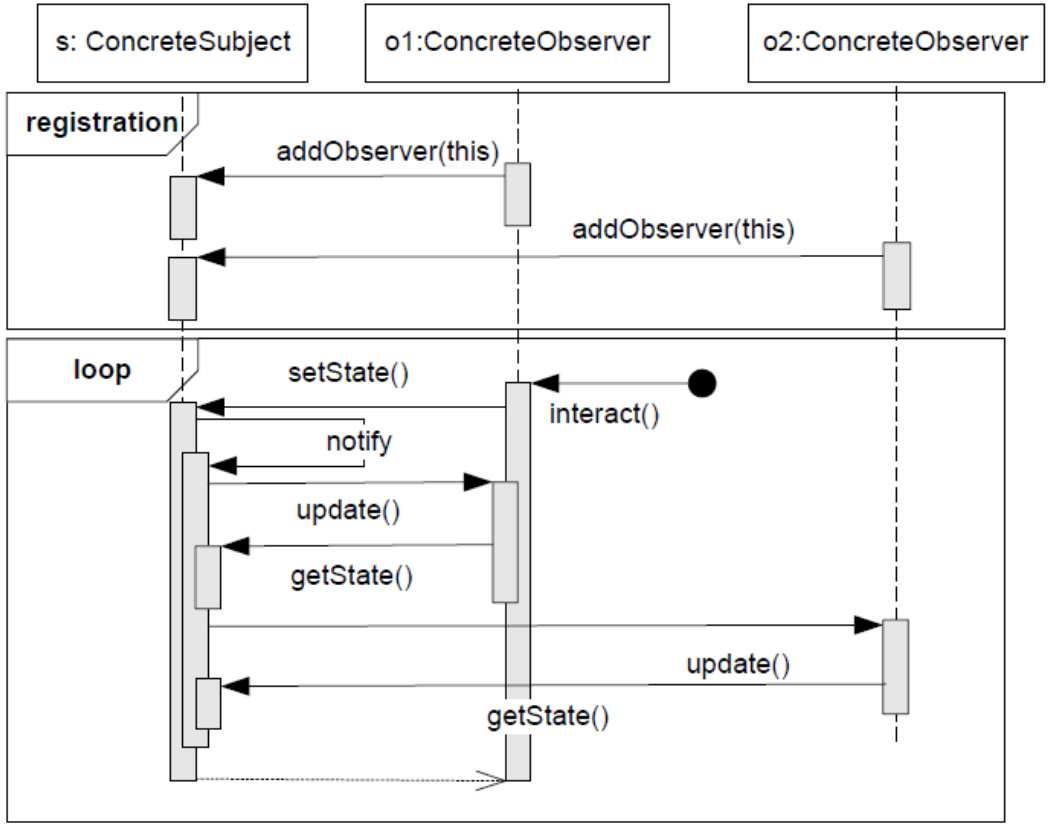
Structure:



Observer Protocol

Protocol:

A convention detailing the expected sequence of interactions or actions expected by a set of roles.



Observer

Benefits

- open ended number of viewer types (run-time binding)
- need not be known at develop time
  - change by addition, not by modification...
- any number of views open at the same time when executing
- all guarantied to be synchronized

Liabilities

- update sequence can become cyclic or costly to maintain

State

Challenge 2:

- Also known as ***state*** *pattern*

Intent

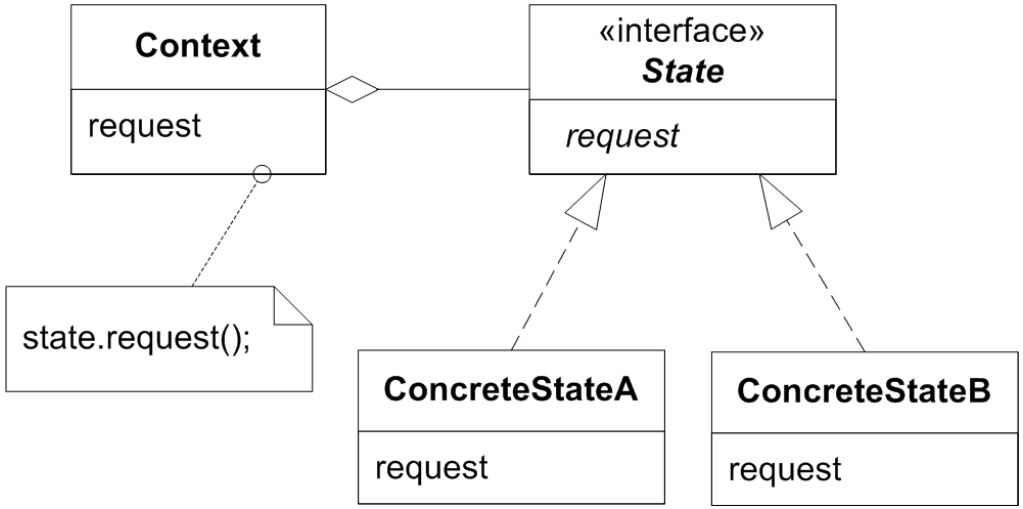
- *Allow an object to alter its behaviour when its internal state changes. The object will appear to change its class.*

- i.e. when the editor is in “draw rectangle” state, the mouse events (click, drag, release) will create a rectangle; when in “select object” state, the same (click, drag, release) will move an object…

State

Consequences

- the manipulation that is active determine the application *state* (“am I moving or resizing figures?”)
- open ended number of manipulations (run-time binding)
- need not know all states at compile time
  - change by addition...



Selected Tool defines the State

In MiniDraw (HotDraw) the editor is in a state that determines how mouse events are interpreted – do they move a checker, do they select a set of figures, or do they create a rectangle?

Mouse events are forwarded to the editor's **tool**. *By changing the tool I change how mouse events are interpreted.*

MVC

The MVC is an architectural pattern because it defines a solution to the problem of structuring the ’large-scale’ / architectural challenge of building graphical user interface applications.

But the ’engine behind the scene’ is a careful combination of **state** and **observer**...

That again are example of using the 3-1-2 variability handling process.

Static view

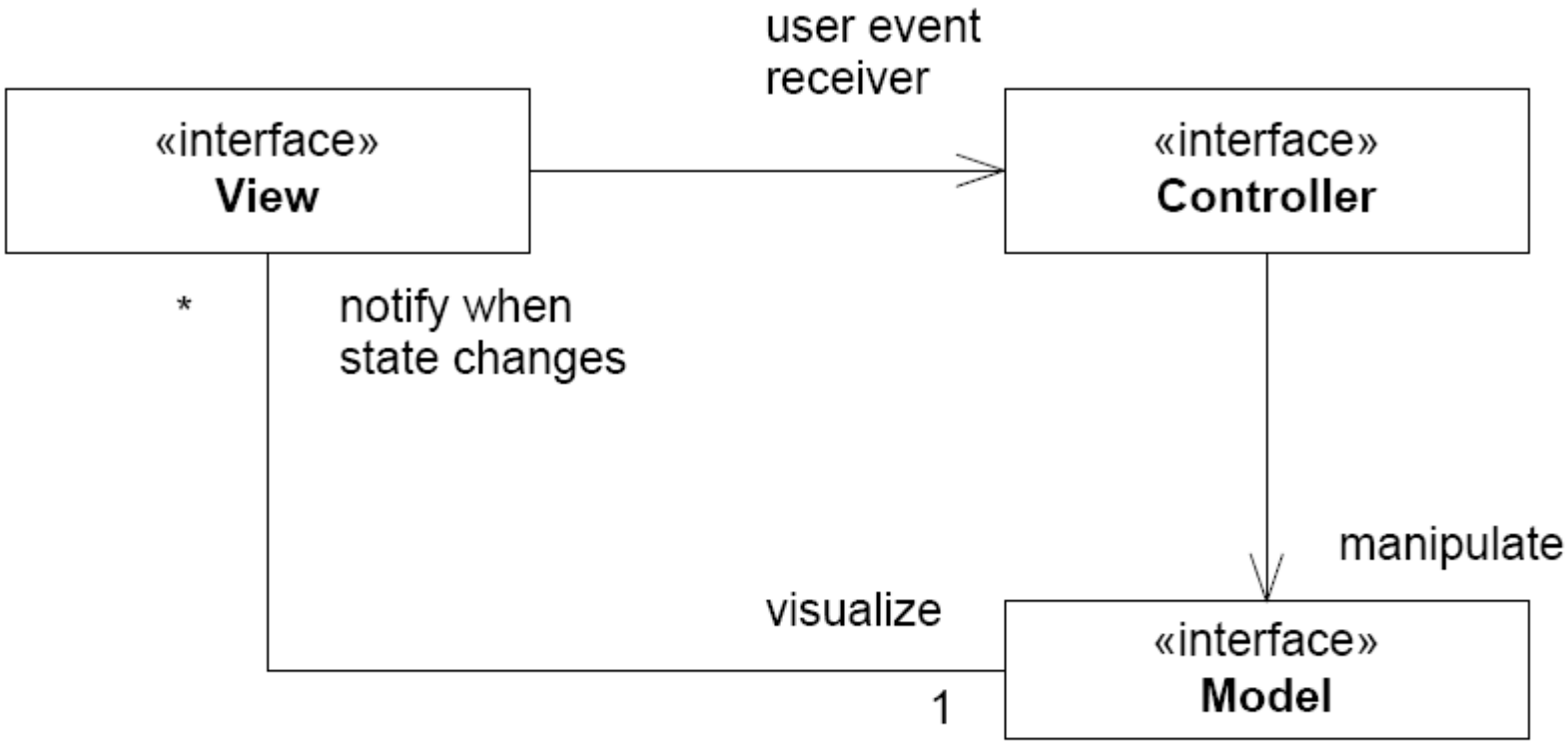


Figure 29.2: MVC role structure.

Responsibilities

Model

- Store application state.
- Maintain the set of Views associated.
- Notify all views in case of state changes.

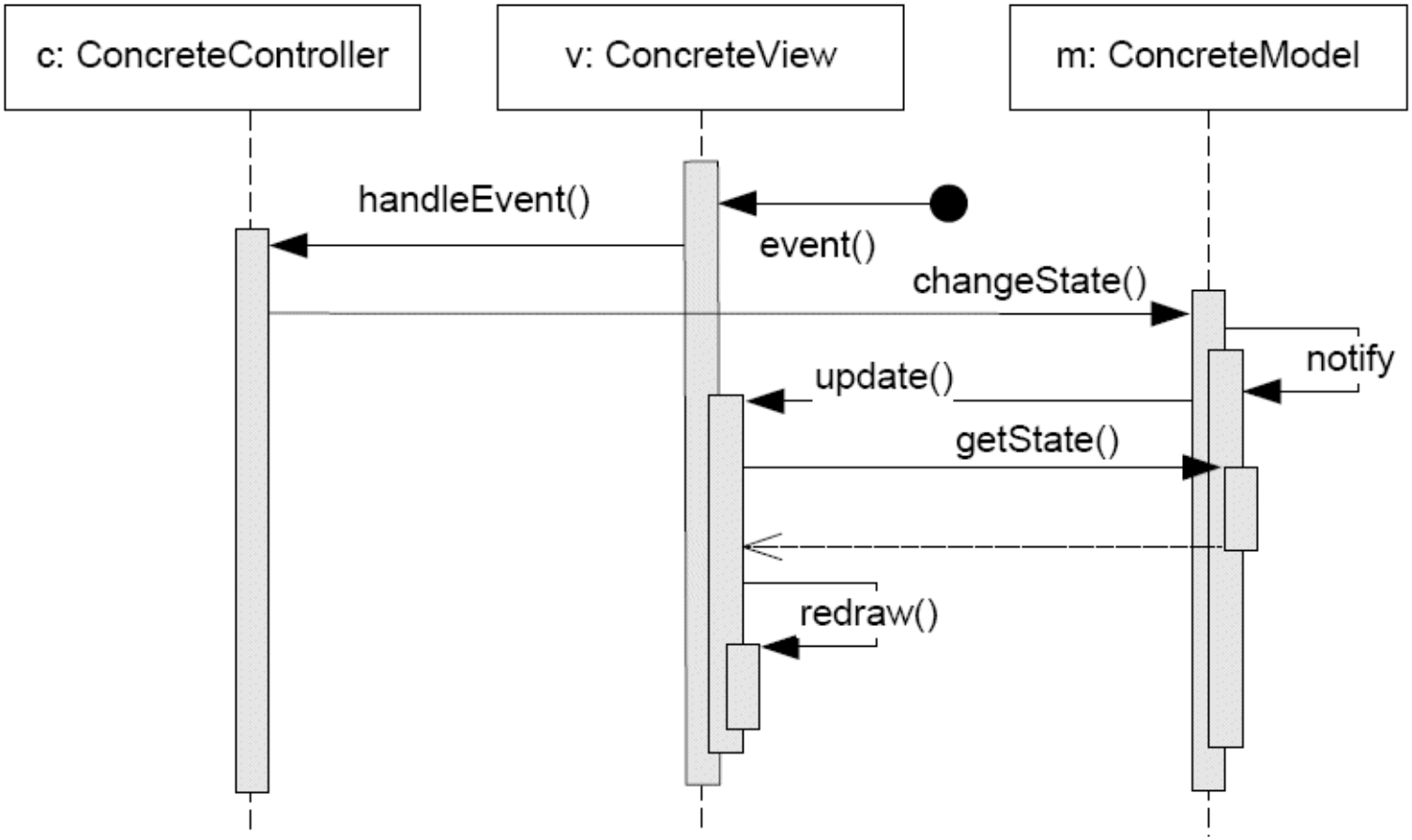
View

- Visualize model state graphically.
- Accept user input evens, delegate them to the associated Controller.
- Potentially manage a set of controllers and allow the user to set which controller is active.

Controller

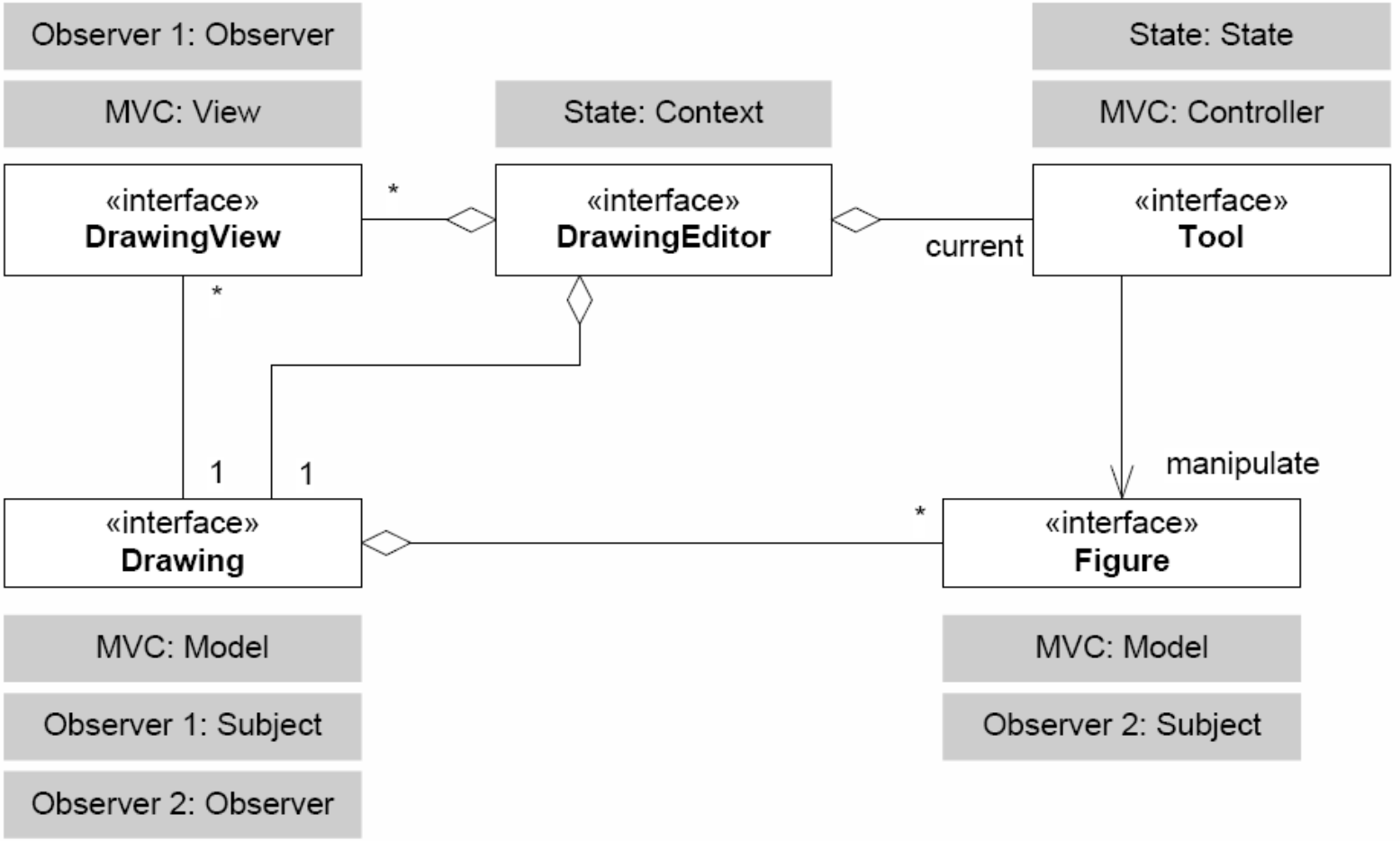
- Interpret user input events and translate them into state changes in the Model.

Dynamics


c: ConcreteController
v: ConcreteView
m: ConcreteModel
handleEvent()
event()
changeState()
notify
update()
getState()
redraw()

MiniDraw

MiniDraw: Static+Pattern View

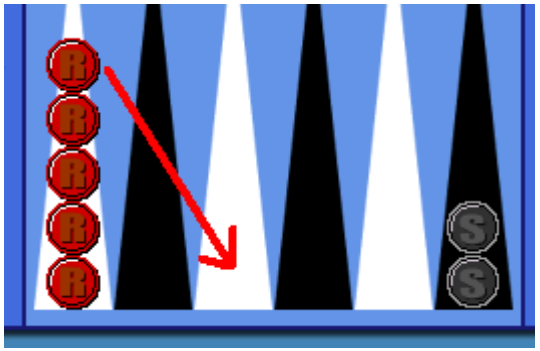


Tool: The Controller role

MiniDraw: Tool Interaction

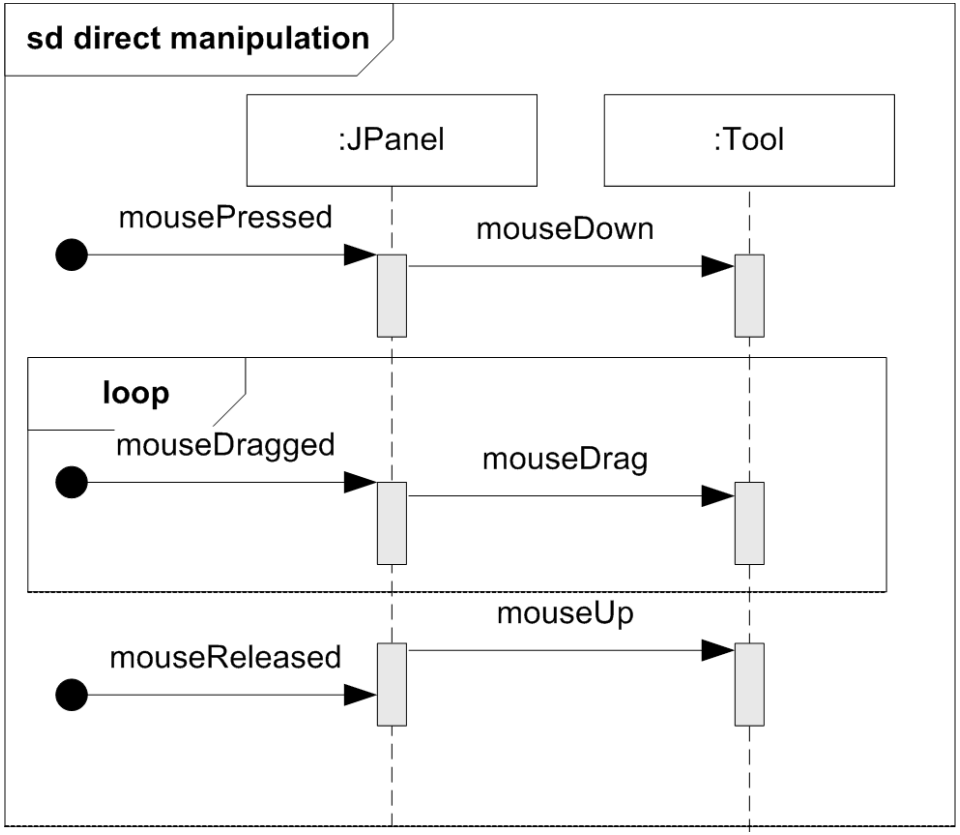
Basic paradigm: *Direct Manipulation*

[Demo: puzzle]



View -> Controller interaction

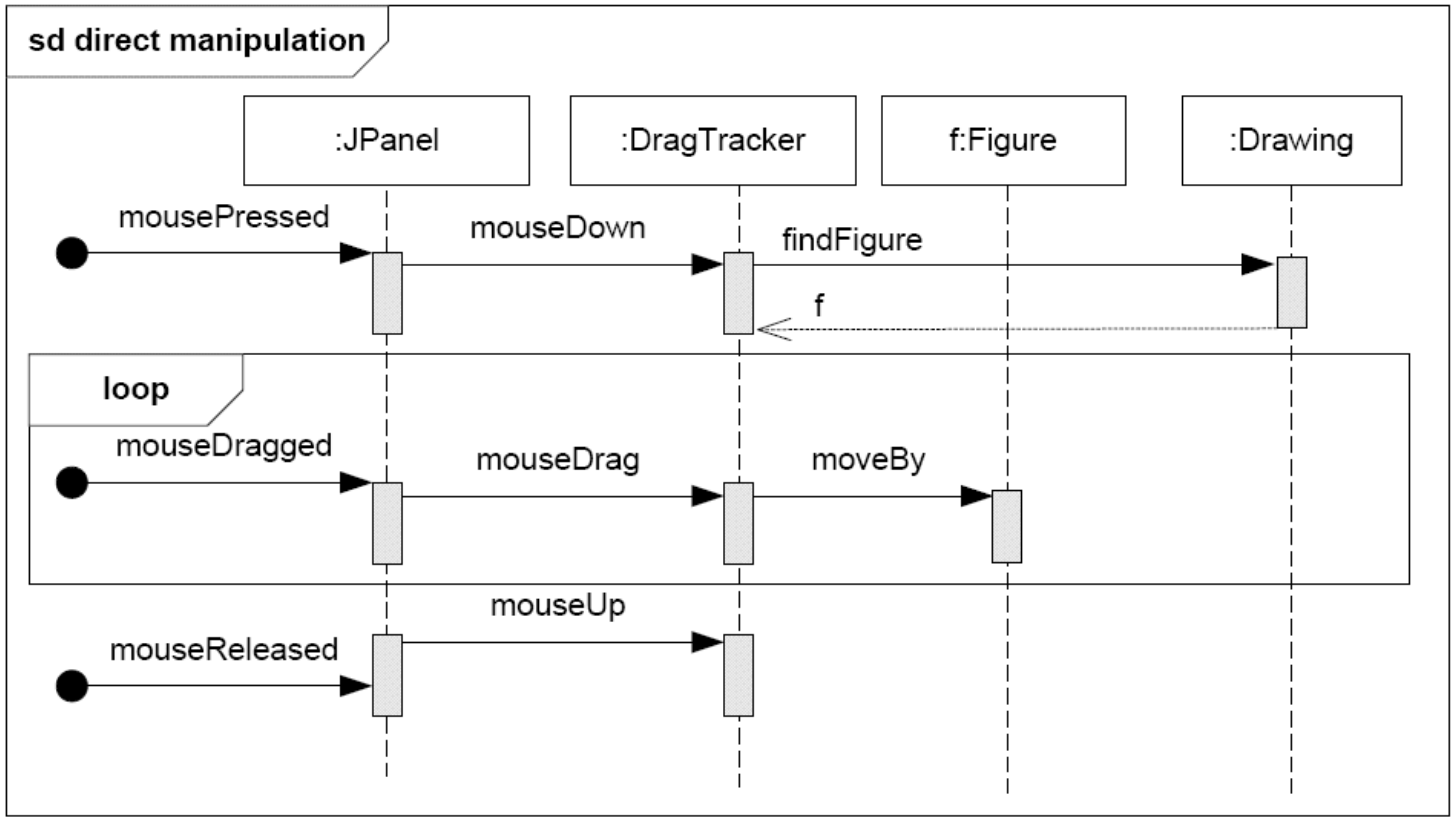
Mouse events *do* hit the JPanel, but MiniDraw simply delegate to its active tool...



Example Tool

Scenario: *User drags image figure around.*

Then a *DragTracker* is the active tool:



The *real* story

… is somewhat more complex as it involves a bit more delegation ☺

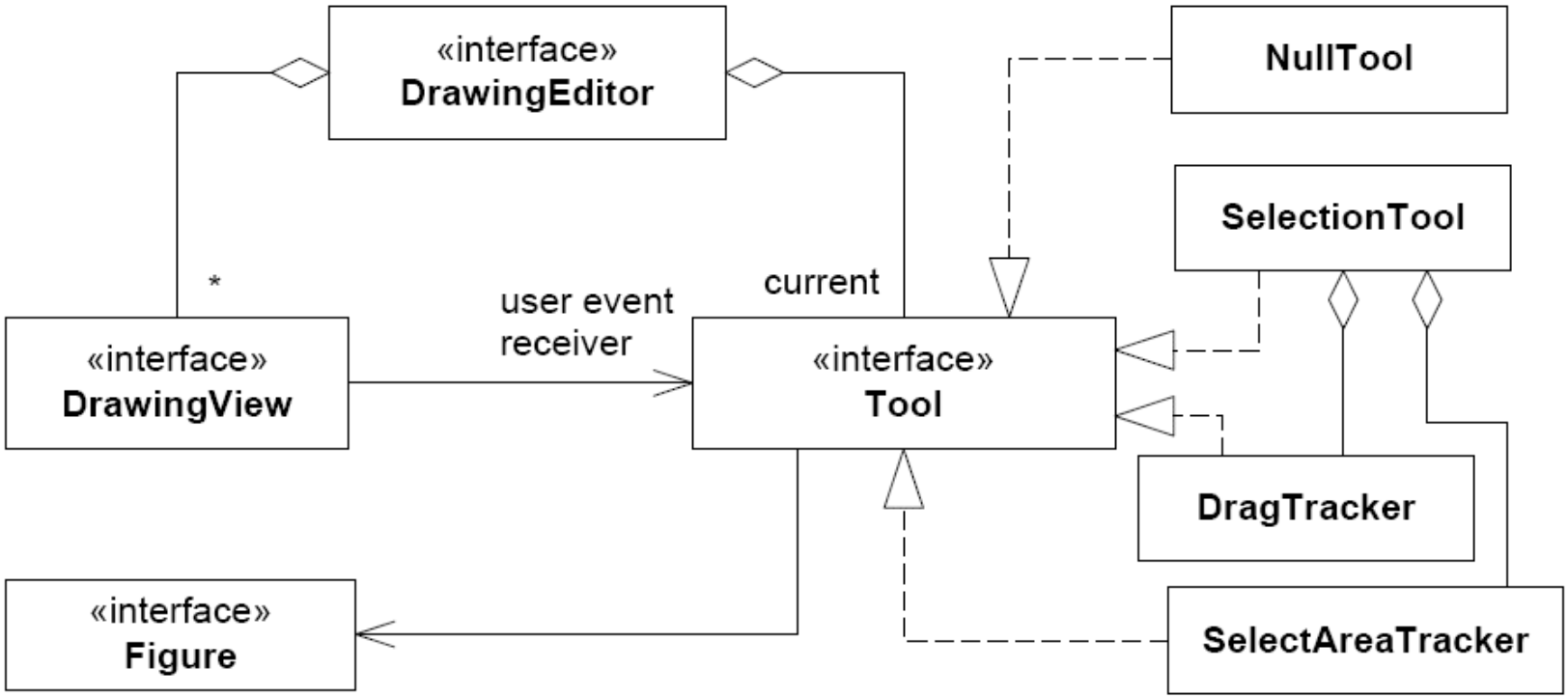
StandardDrawingView is-a JPanel.

– This view requests access to the editor's current tool

```
/**
 * Handles mouse down events. The event is delegated to the
 * currently active tool.
 */
public void mousePressed(MouseEvent e) {
  requestFocus();
  Point p = constrainPoint(new Point(e.getX(), e.getY()));
  fLastClick = new Point(e.getX(), e.getY());
  editor.tool().mouseDown(e, p.x, p.y);
  checkDamage();
}
```

Tools

MiniDraw has some simple tools defined



Code view

It is very simple to set a new tool:

```
editor.setTool( t );
```

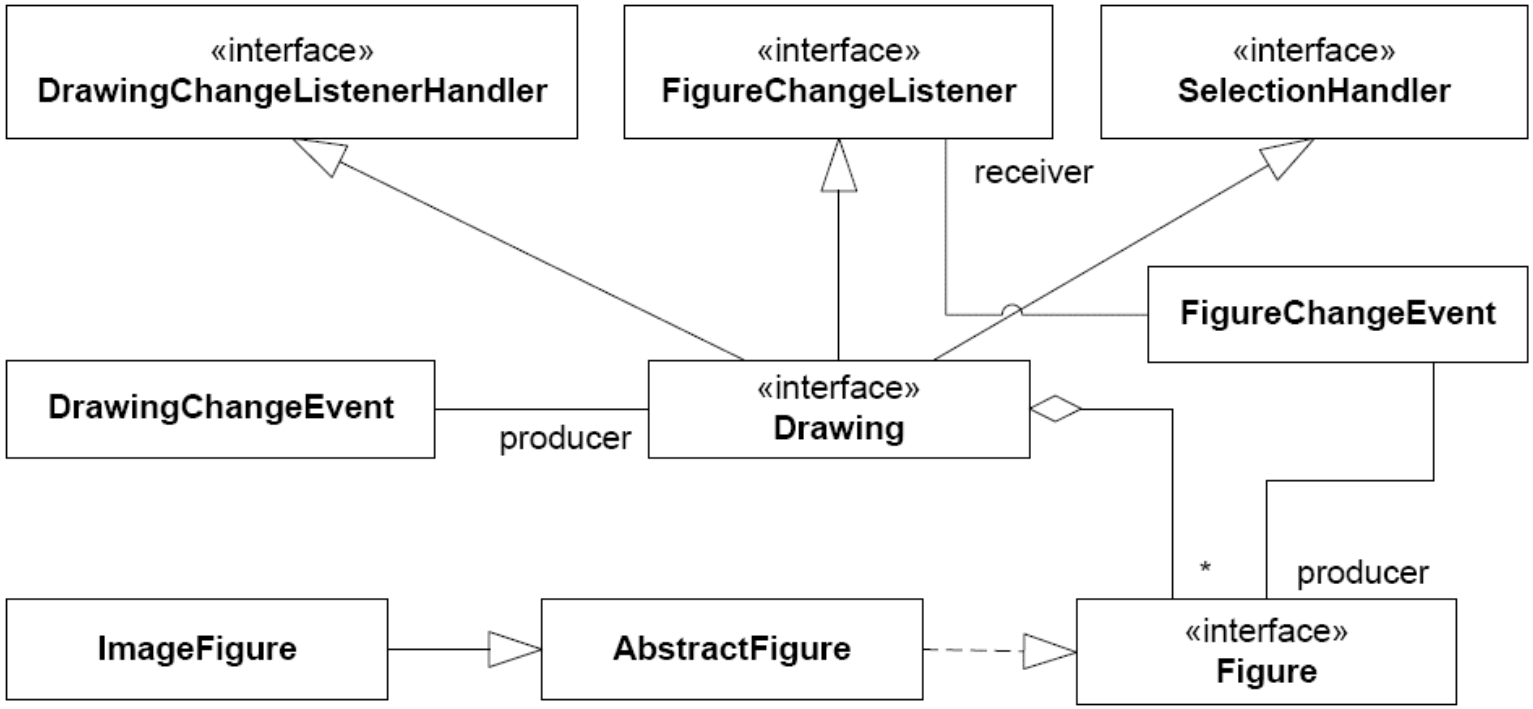
where t is the tool you want to become active.

NullTool is a *Null Object:* a tool that does nothing.

Drawing: The Model role

MiniDraw: Drawing

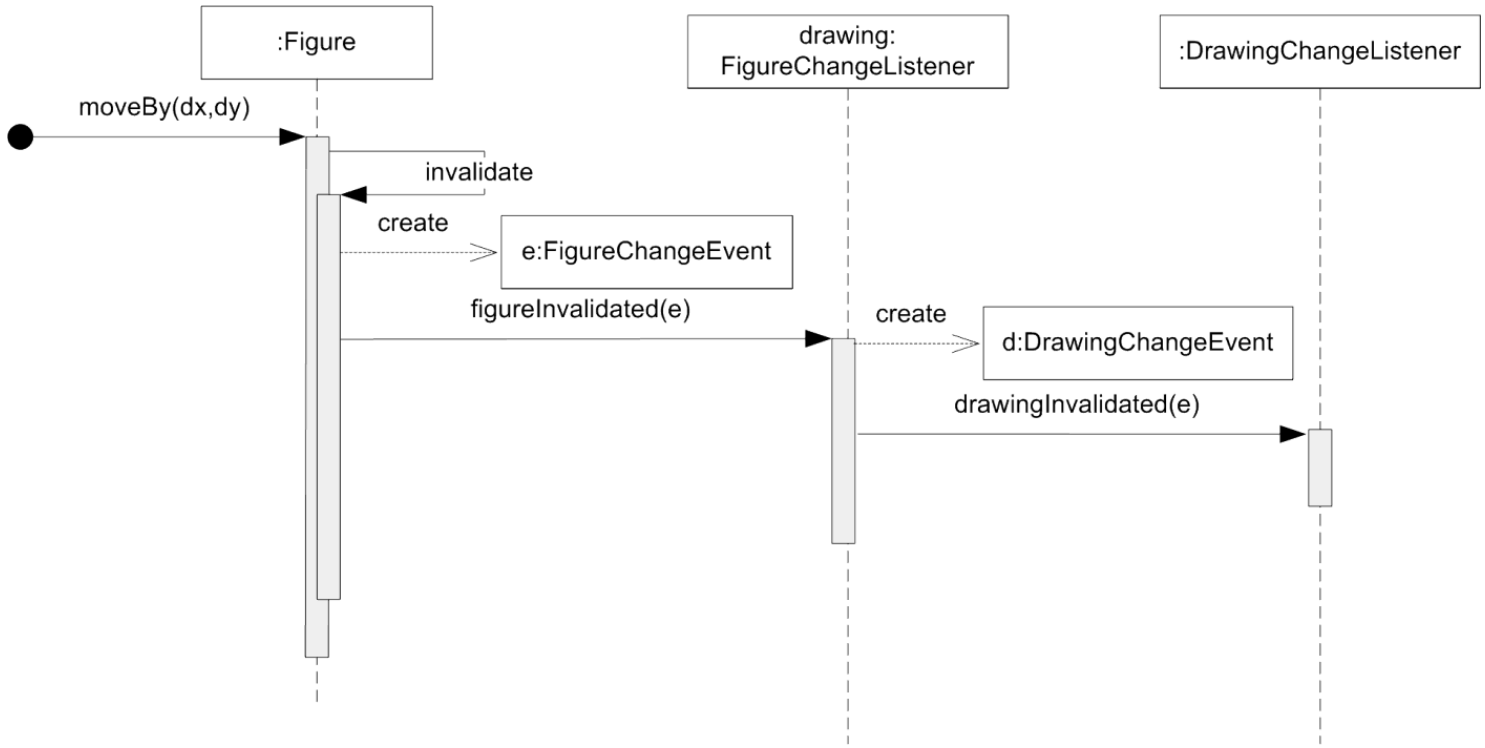
Static view



MiniDraw: Drawing

But how does the view get repainted?

- Double observer chain
  - Figure *notifies* drawing *notifies* drawing view.

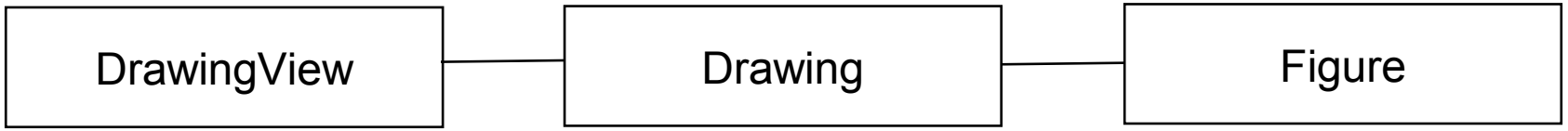


Exercise:

Observer pattern has two *roles*

- Subject: Container of data
- Observer: Object to notify upon data changes

Who are who here???

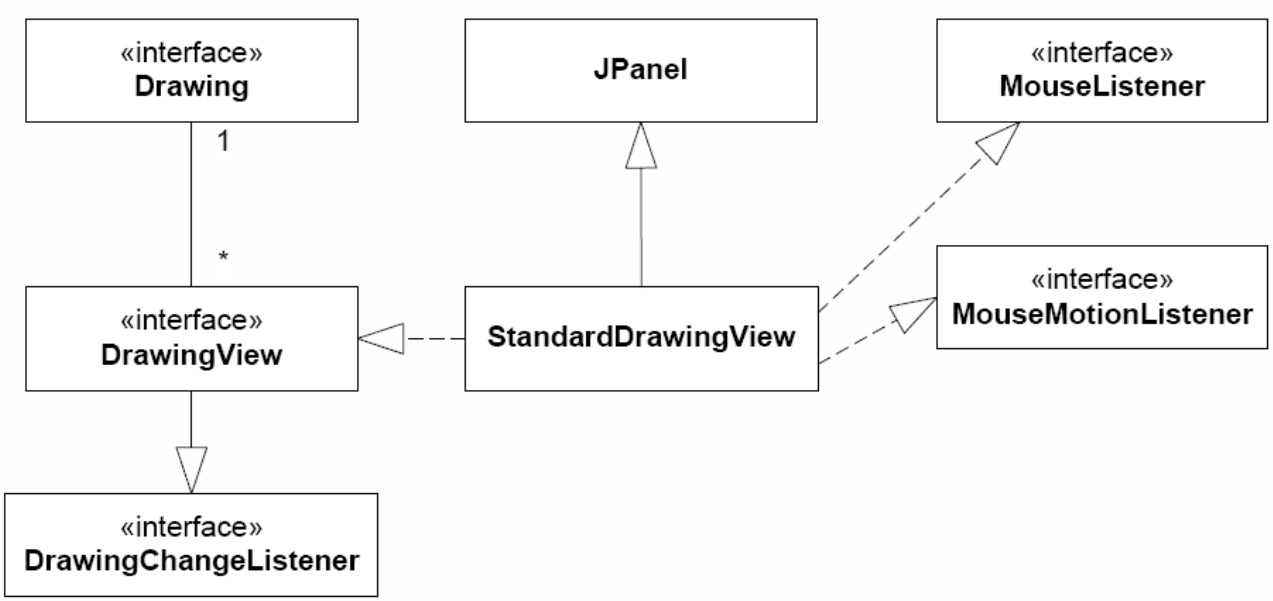


DrawingView: The View role

View

The View is rather simple

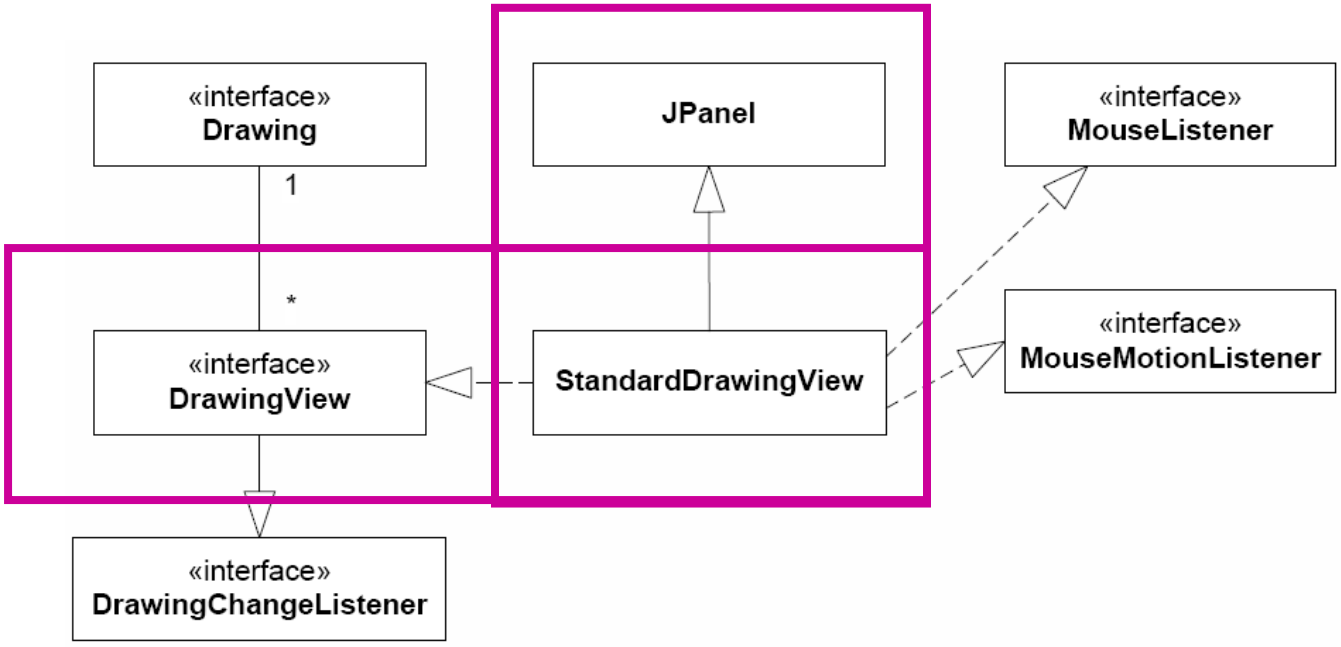
- JPanel to couple MiniDraw to concrete Swing GUI implementation
- Listen to mouse events to forward them to tool/controller.



The Compositional Advantage

Note that this design **combines two frameworks**

- MiniDraw and Swing
- If DrawingView was *not* an interface then ☠

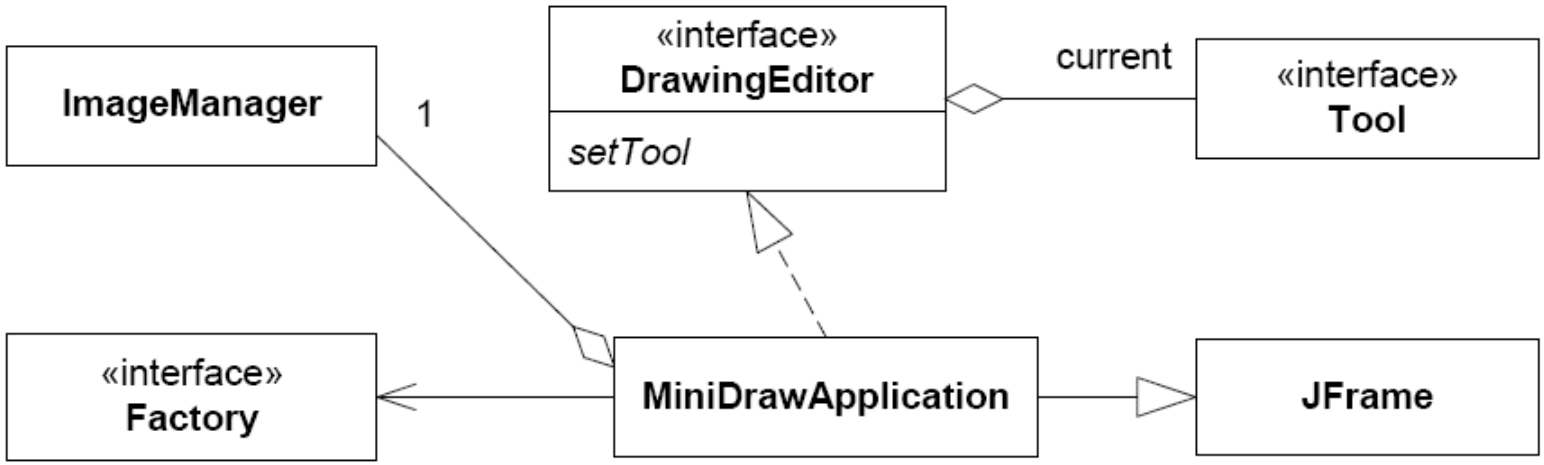


DrawingEditor: The Coordinator

Static View

DrawingEditor

- Main class of a minidraw application, that is the editor must instantiate all parts of the application.
- Opens a window to make a visible application.
- Acts as central access point for the various parts of MiniDraw.
- Allows changing the active tool.
- Allows displaying a message in the status bar.



Implementation

Default Implementations

Most MiniDraw roles have default implementations:

- Interface `X` has default implementation `StandardX`
- `Drawing -> StandardDrawing`

There are also some partial implementations:

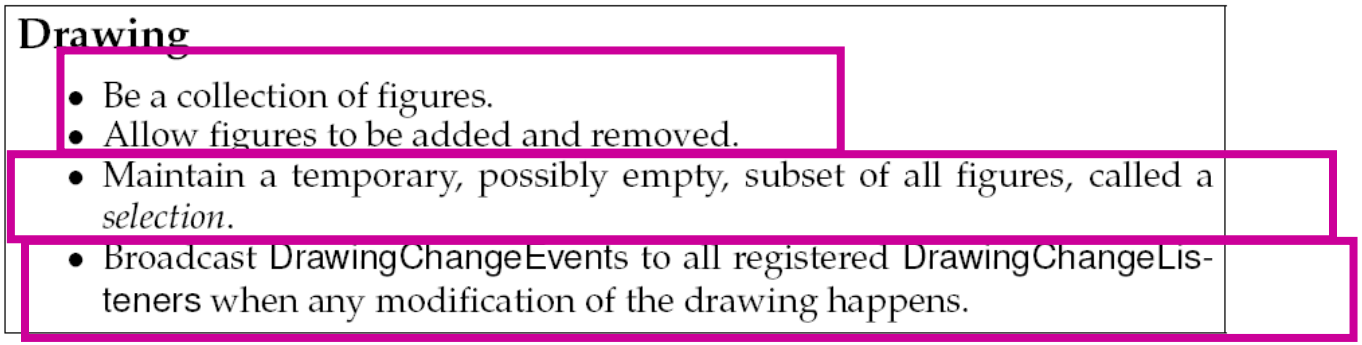
- Interface `X` has partial implementation `AbstractX`
- `Tool -> AbstractTool`
- `Figure -> AbstractFigure`

Compositional Design

Complex behaviour as a result of combining simple behaviour...

Example:

- StandardDrawing
- Responsibilities



Drawing

- Be a collection of figures.
- Allow figures to be added and removed.
- Maintain a temporary, possibly empty, subset of all figures, called a *selection*.
- Broadcast DrawingChangeEvents to all registered DrawingChangeListeners when any modification of the drawing happens.

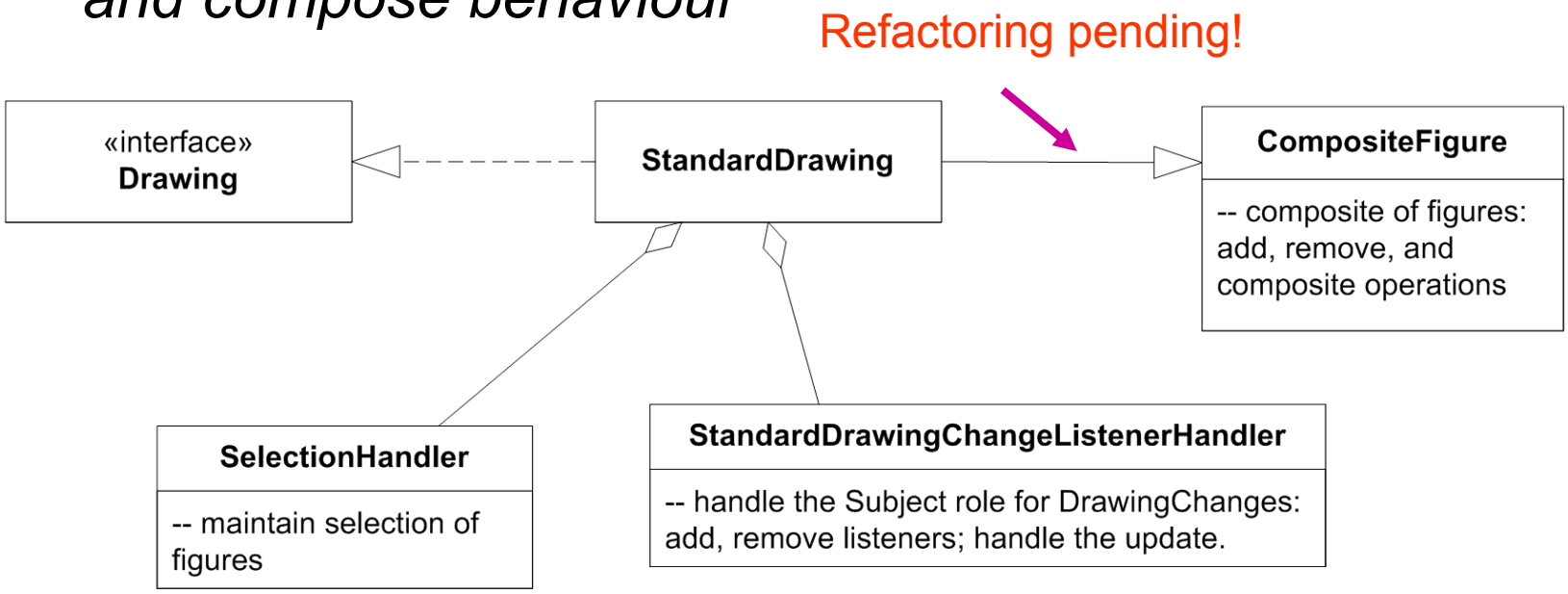
How do we do that?

Proposal 1:

– *implement ahead...*

Proposal 2:

– *encapsulate major responsibilities in separate objects and compose behaviour*



Code view: delegations!

Examples:

```
/**
 * Adds a listener for this drawing.
 */
public void addDrawingChangeListener(DrawingChangeListener
                                     listener) {
  listenerHandler.addDrawingChangeListener(listener);
}
[...]
/**
 * Get a list of all selected figures
 */
public List<Figure> selection() {
  return selectionHandler.selection();
}
```

What do I achieve?

Implementing a custom Drawing

- In which the figure collection works differently…
- but I can reuse the selection and drawing-change handler behaviour directly!

```
public class UnitDrawing implements Drawing, GameObserver {
  /** list of all figures currently selected */
  protected SelectionHandler selectionHandler;

  /** use a StandardDrawingChangeListenerHandler to handle all
  observer pattern subject role behavior */
  protected StandardDrawingChangeListenerHandler listenerHandler;
```

```
@Override
public void addToSelection(Figure arg0) {
  selectionHandler.addToSelection(arg0);
}

@Override
public void clearSelection() {
  selectionHandler.clearSelection();
}

@Override
public void removeFromSelection(Figure arg0) {
  selectionHandler.removeFromSelection(arg0);
}
```

MiniDraw Variability Points

Variability Points

Images
- By putting GIF images in the right folder and use them through ImageFigures

Tools
- Implement Tool and invoke editor.setTool(t)

Figures
- You may make any new type you wish

Drawing
- Own collection of figures (e.g. observe a game instance)

Observer Figure changes
- Make semantic constraints

Views
- Special purpose rendering

Summary

MiniDraw is

- A *framework*: A skeleton application that can be tailored for a specific purpose
- A *demonstration:*
  - of MVC, Observer, State, Abstract Factory, Null Object, Strategy, ...
  - of compositional design: *Make complex behaviour by combining simpler behaviours*
- A *basis:* for the mandatory project GUI.