Programming Languages and Techniques (CIS120)

Lecture 35

November 30th 2015

Design Patterns

Model / View / Controller

Chapter 31

Game project grading

- Game Design Proposal Milestone Due: (12 points)
  Tuesday December 1st at 11:59pm
  – (Should take about 1 hour)
- Final Program Due: (88 points)
  Tuesday December 8th at 11:59pm
  – Submit zipfile online, submission *only* checks if your code compiles
- Grade based on demo with your TA during reading days
  – Make sure that you test your program in Moore 100, especially if you use outside libraries
  – Grading rubric on the assignment website
  – Recommendation: don't be too ambitious.

- *NO LATE SUBMISSIONS PERMITTED*

How is the Game Project going so far?

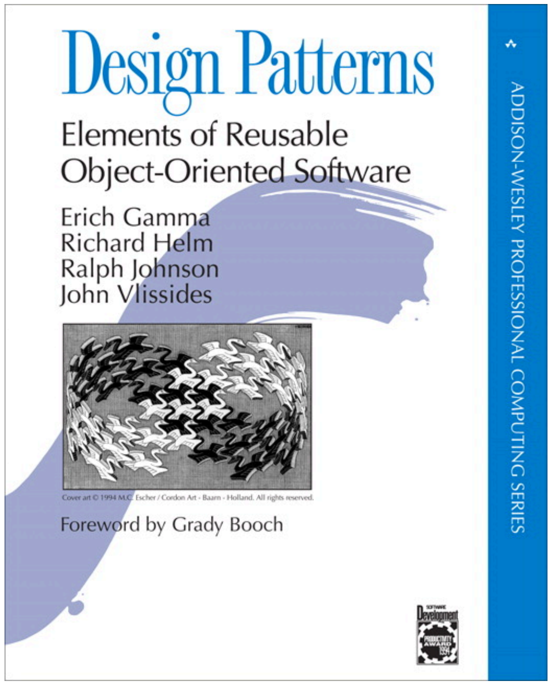
1. not started
2. got an idea
3. submitted design proposal
4. started coding
5. it's somewhat working
6. it's mostly working
7. debugging / polishing
8. done!

Course Trajectory

- Today: Thinking about software design at a larger scale
  - (Much more than we can cover)
- Java loose ends
  - Hashing and hashCode
- Touching on Java advanced concepts
  - Garbage collection
  - Concurrency

Design Patterns

- Design Patterns
  - Influential OO design book published in 1994
  - Identifies many common situations and "patterns" for implementing them in OO languages


Design Patterns
Elements of Reusable Object-Oriented Software
Erich Gamma
Richard Helm
Ralph Johnson
John Vlissides
Foreword by Grady Booch
ADDISON-WESLEY PROFESSIONAL COMPUTING SERIES

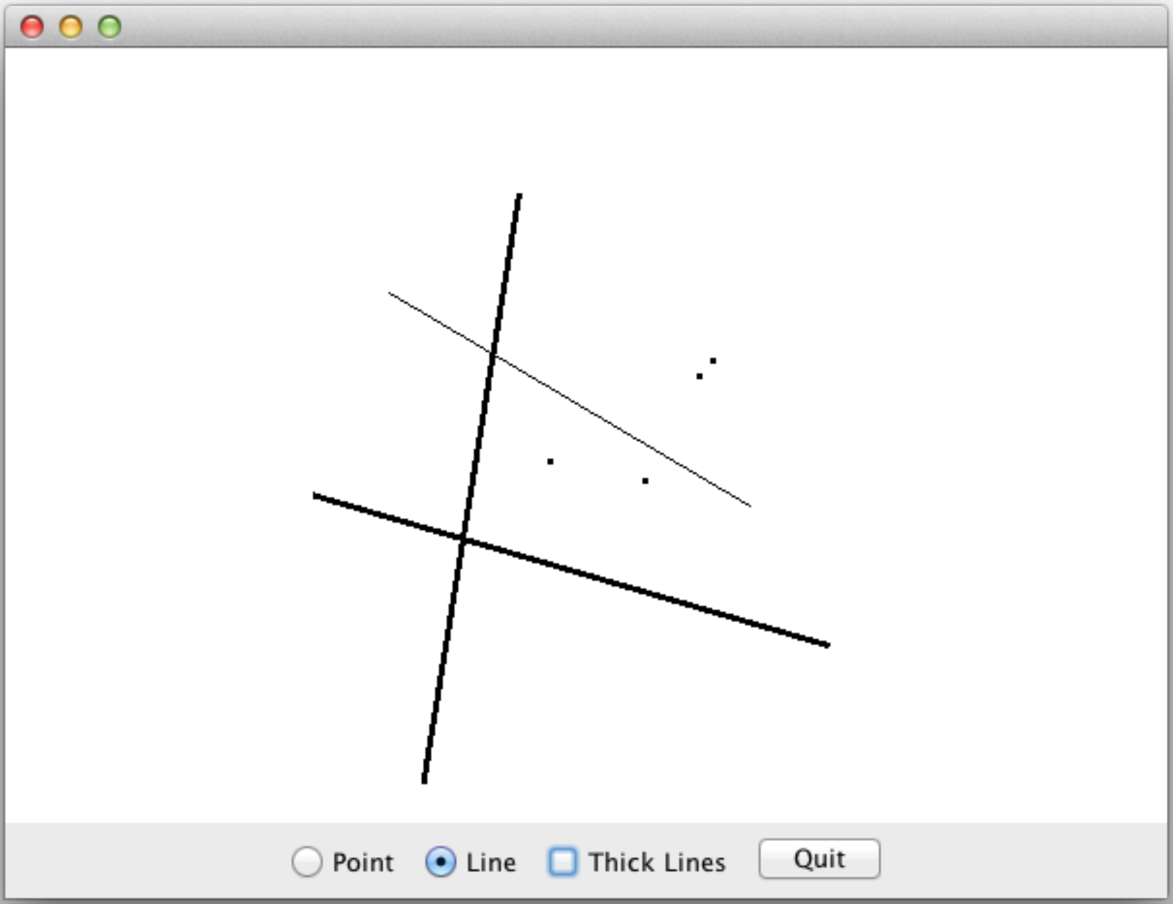
- Some we have seen explicitly:
  - e.g. *Iterator* pattern
- Some we've used but not explicitly described:
  - e.g. The Broadcast class from the Chat HW uses the *Factory* pattern
- Some are workarounds for OO's lack of some features:
  - e.g. The *Visitor* pattern is like OCaml's fold + pattern matching

GUI Design Patterns

Model/View/Controller

Adapters

Example 1: Java Paint



Paint Program Structure

- Main frame for application (class Paint)
  - List of shapes to draw
  - The current color
  - The current line thickness

Model

- Drawing panel (class Canvas, inner class of Paint)

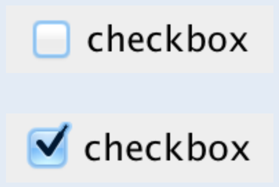
View

- Control panel (class JPanel
  - Contains radio buttons for selecting shape to draw
  - Line thickness checkbox, undo and quit buttons

Controller

- Connections between Preview shape (if any…)
  - Preview Shape: View <-> Controller
  - MouseAdapter: Controller <-> Model

Example 2: CheckBox



true or false

Views

Selected?
Pressed?

Model

`setSelected`

`mouseListener`

`keyListener`

Controllers

`Class JToggleButton.ToggleButtonModel`

`boolean`	`isSelected()`	Checks if the button is selected.
`void`	`setPressed(boolean b)`	Sets the pressed state of the button.
`void`	`setSelected(boolean b)`	Sets the selected state of the button.

Example 3: Chat Server

```
getChannels
getUsers
getOwner
…
```

Views

Internal Representation

```
owners: Map<Channel,
               Users>
users: Map<Channel,
            Set<Users>>
…
```

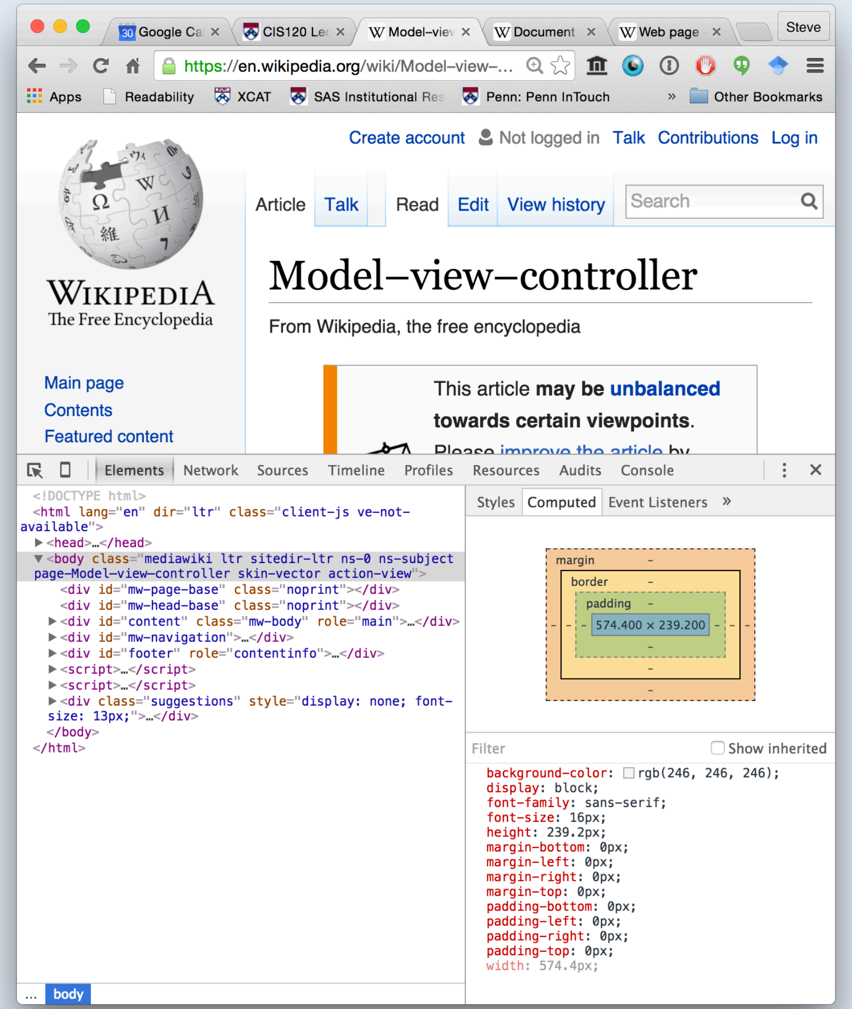
Model

```
createChannel
joinChannel
invite
kick
…
```

Controllers

`ServerModel`

Example 4: Web Pages



Model–view–controller

From Wikipedia, the free encyclopedia

This article **may be unbalanced towards certain viewpoints**. Please improve the article by

```
<!DOCTYPE html>
<html lang="en" dir="ltr" class="client-js ve-not-available">
  ▶<head>…</head>
  ▼<body class="mediawiki ltr sitedir-ltr ns-0 ns-subject page-Model–view–controller skin-vector action-view">
      <div id="mw-page-base" class="noprint"></div>
      <div id="mw-head-base" class="noprint"></div>
    ▶<div id="content" class="mw-body" role="main">…</div>
    ▶<div id="mw-navigation">…</div>
    ▶<div id="footer" role="contentinfo">…</div>
    ▶<script>…</script>
    ▶<script>…</script>
    ▶<div class="suggestions" style="display: none; font-size: 13px;">…</div>
    </body>
</html>
```

```
background-color: rgb(246, 246, 246);
display: block;
font-family: sans-serif;
font-size: 16px;
height: 239.2px;
margin-bottom: 0px;
margin-left: 0px;
margin-right: 0px;
margin-top: 0px;
padding-bottom: 0px;
padding-left: 0px;
padding-right: 0px;
padding-top: 0px;
width: 574.4px;
```

Views

Internal Representation: DOM (Document Object Model)

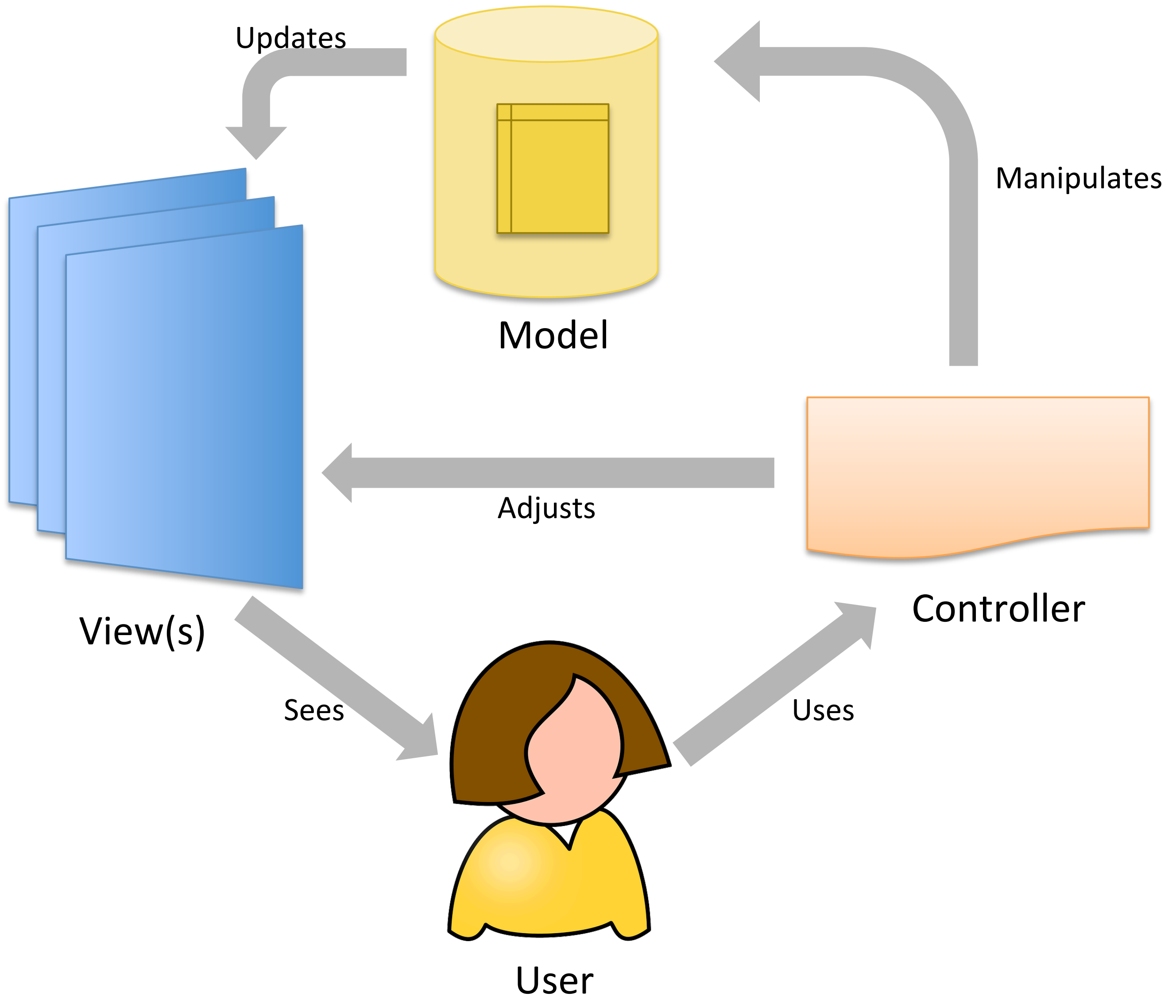
Model

JavaScript API

`document.addEventListener()`

Controllers

MVC Pattern


Updates
Model
Manipulates
Adjusts
View(s)
Controller
Sees
Uses
User

MVC Benefits?

- Decouples important "model state" from how that state is presented and manipulated
  - Suggests where to insert interfaces in the design
  - Makes the model testable independent of the GUI
- Multiple views
  - e.g. from two different angles, or for multiple different users
- Multiple controllers
  - e.g. mouse vs. keyboard interaction

MVC Variations

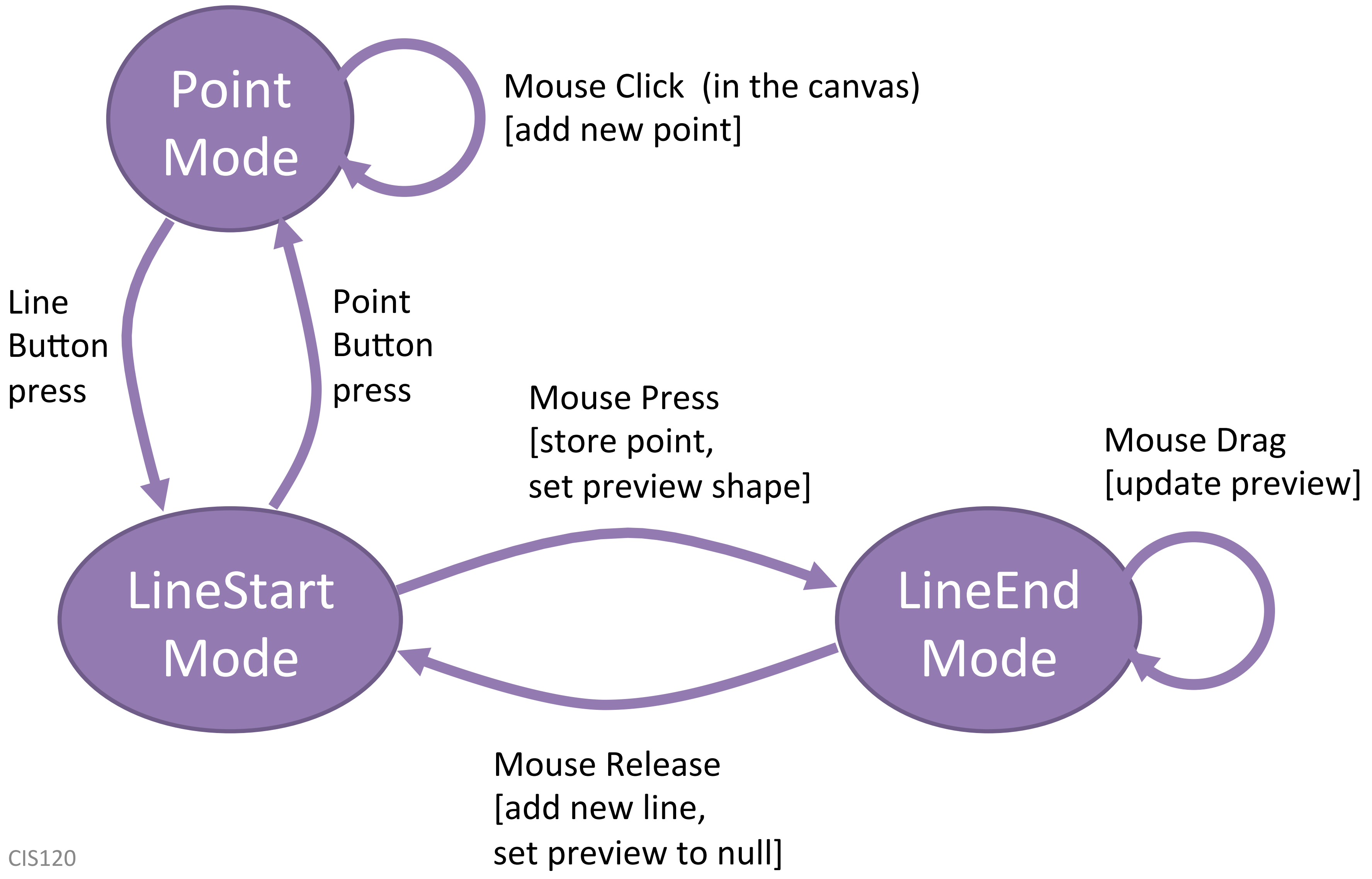
- Many variations on MVC pattern
- Hierarchical / Nested
  - As in the Swing libraries, in which JComponents often have a "model" and a "controller" part
- Coupling between Model / View or View / Controller
  - e.g. in Paint the Model and the View are quite coupled because the model caries most of the information about the view

Adapters

MouseAdapter

KeyBoardAdapter

Mouse Interaction in Paint



Two interfaces for mouse listeners

```
interface MouseListener extends EventListener {
  public void mouseClicked(MouseEvent e);
  public void mouseEntered(MouseEvent e);
  public void mouseExited(MouseEvent e);
  public void mousePressed(MouseEvent e);
  public void mouseReleased(MouseEvent e);
}
```

```
interface MouseMotionListener extends EventListener {
   public void mouseDragged(MouseEvent e);

   public void mouseMoved(MouseEvent e);
}
```

Lots of boilerplate

- There are seven methods in the two interfaces.
- We only want to do something interesting for three of them.
- Need "trivial" implementations of the other four to implement the interface…

```
public void mouseMoved(MouseEvent e)   { return; }
public void mouseClicked(MouseEvent e) { return; }
public void mouseEntered(MouseEvent e) { return; }
public void mouseExited(MouseEvent e)  { return; }
```

- Solution: MouseAdapter class…

Adapter classes:

- Swing provides a collection of abstract event adapter classes
- These adapter classes implement listener interfaces with empty, do-nothing methods
- To implement a listener class, we extend an adapter class and override just the methods we need

```
private class Mouse extends MouseAdapter {
   public void mousePressed(MouseEvent e) { … }
   public void mouseReleased(MouseEvent e) { … }
   public void mouseDragged(MouseEvent e) { … }
}
```