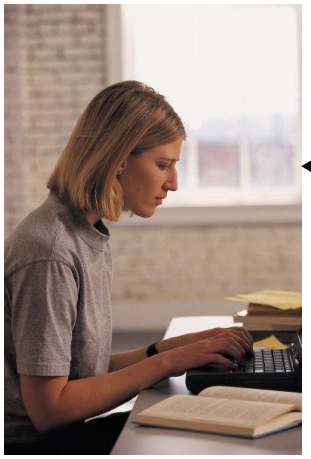
MVC:
Model View Controller

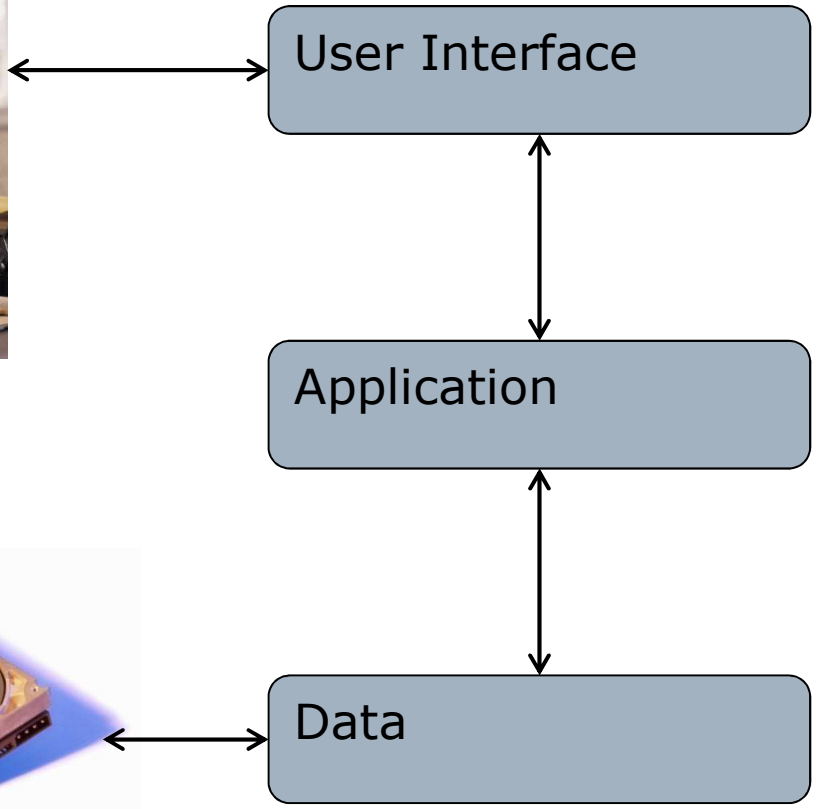
Lecture xx

Motivation

- Basic parts of any application:
  - Data being manipulated
  - A user-interface through which this manipulation occurs
- The data is logically independent from how it is displayed to the user
  - Display should be decoupled from content
  - Single-point-of-control over change
- Example: grade distribution in class
  - Could be displayed as a pie chart, or a bar chart, or a cumulative fraction plot, or…

Architecture: Desktop App





Graphical events (mouse moves, button pushed)

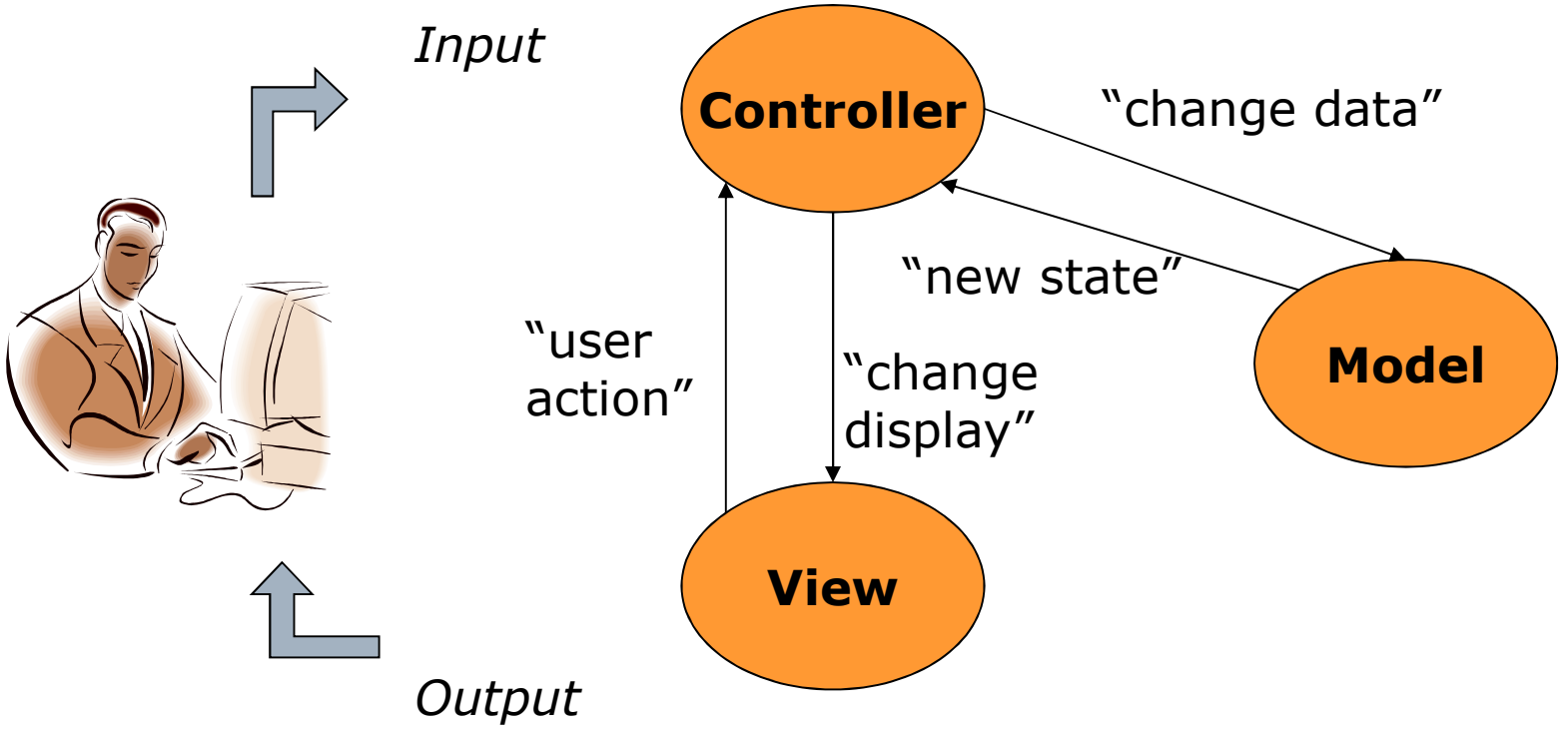
Processing, Calculating

Persistence, Transactions, Triggers

Model-View-Controller Pattern

- Model
  - The data (*i.e.* state)
  - Methods for accessing and modifying state
- View
  - Renders contents of model for user
  - When model changes, view must be updated
- Controller
  - Translates user actions (*i.e.* interactions with view) into operations on the model
  - Example user actions: button clicks, menu selections

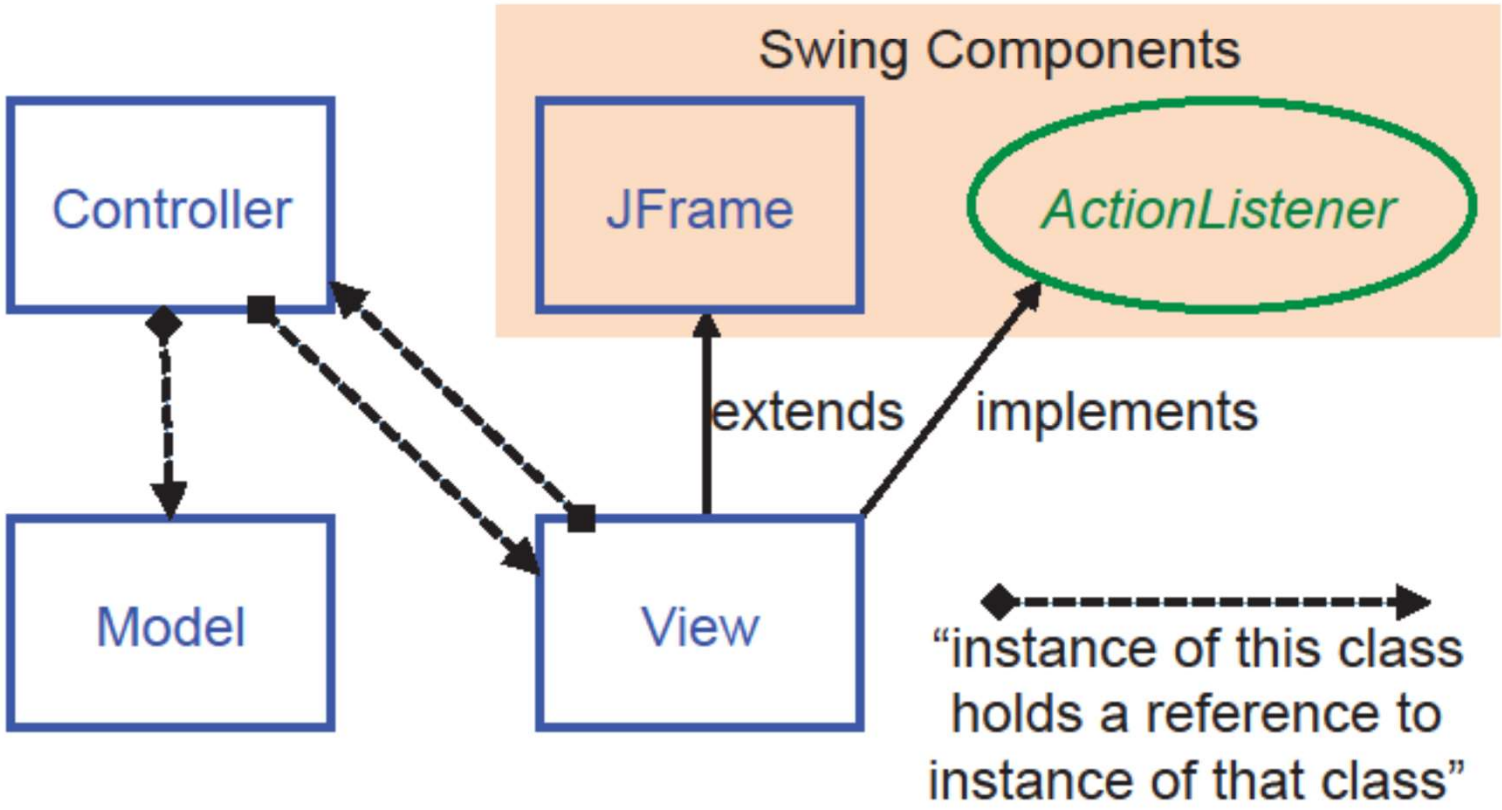
Basic Interactions in MVC



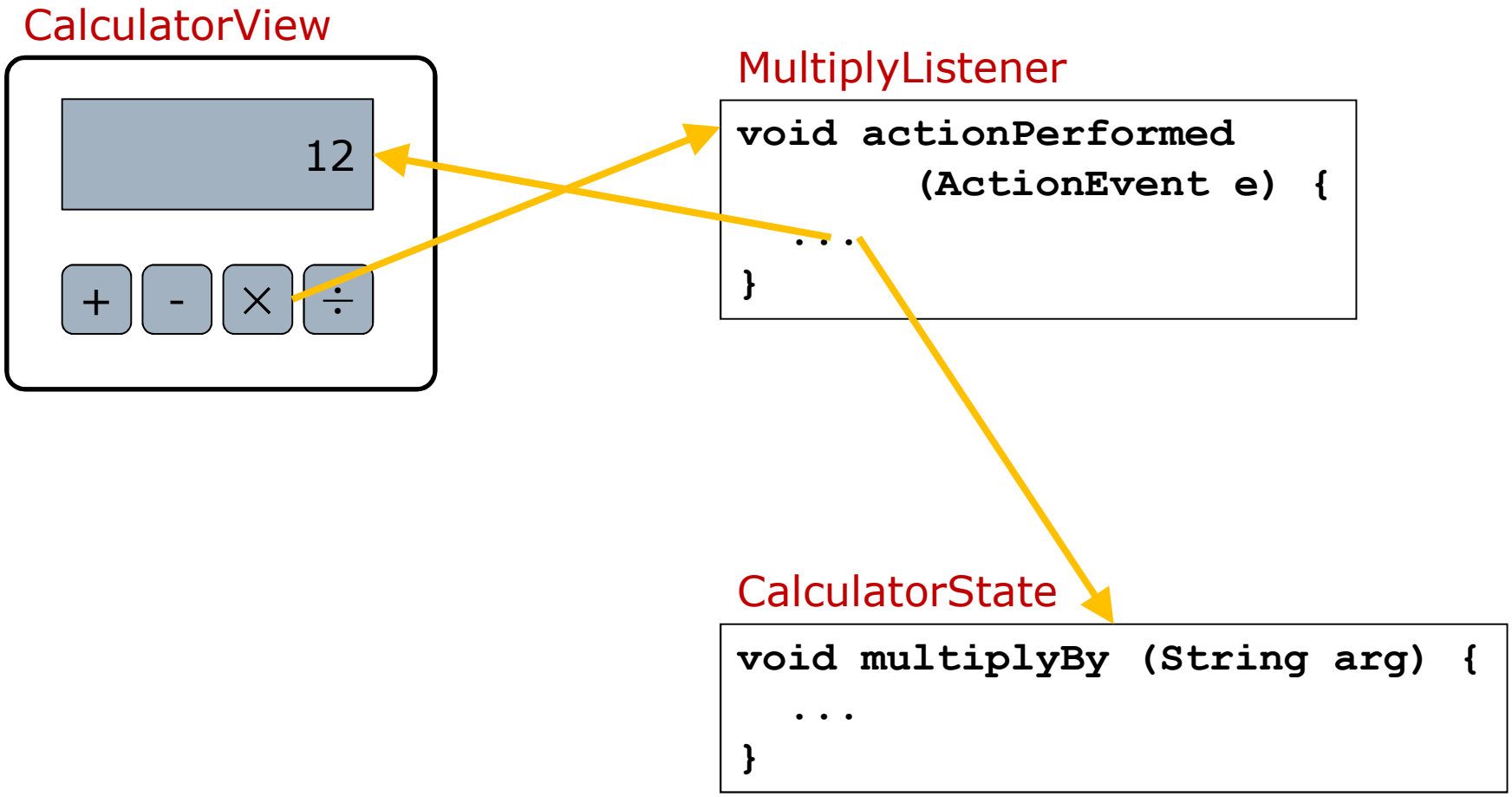
Implementing Basic MVC in Swing

- Mapping of classes to MVC parts
  - View is a Swing widget (**`JFrame`**, **`JButton`**, *etc*.)
  - Controller is an event handler (**`ActionListener`**)
  - Model is an ordinary Java class (or database)
- Alternative mapping
  - View is a Swing widget and includes (inner) class(es) as event handlers
  - Controller is an ordinary Java class with "business logic", invoked by event handlers in view
  - Model is an ordinary Java class (or database)
- Difference: Where is the event listener?
  - Regardless, model and view are completely decoupled (linked only by controller)

Example: Simple MVC GUI Demo



Wiring Parts Together



Configuration: Connecting Parts

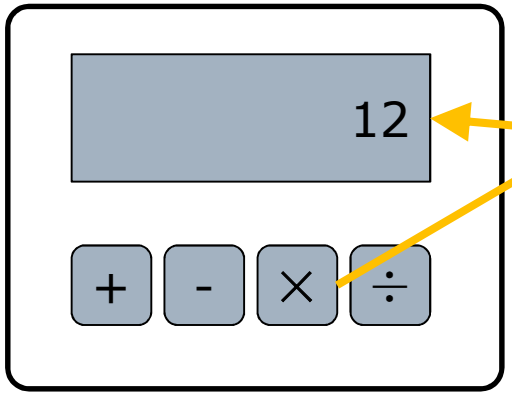

```
public class CalcView extends JFrame {
  private JButton multiplyBtn = new JButton("X");

  public void register(ActionListener x) {
    multiplyBtn.addActionListener(x);
  }
}

public class CalcController {
  ...
  view.register(new ActionListener() {
    public void actionPerformed(ActionEvent e) {
      ...
    }
  });
}
```

Basic MVC in JavaScript

- Mapping of objects to MVC parts
  - View is an HTML page
  - Controller is event handler, an ordinary JavaScript function
  - Model is an ordinary JavaScript object
- Alternative mapping
  - Separate event handler(s) from controller
  - Controller is an ordinary object with "business logic", invoked by event handlers
  - Model is an ordinary object
- Difference: Where is the event listener?
  - Regardless, model and view are completely decoupled (linked only by controller)

Wiring Parts Together

Calculator.html



ActionListener.js

```
function multiplyListener (event) {
   ...
}
```

CalculatorState.js

```
function multiplyBy (arg) {
   ...
}
```

Registering an Event Handler

- Three techniques, ordered from:
  - Oldest (most brittle, most universal) to
  - Newest (most general, least standard)

1. Inline (link in HTML itself)

```
<a href="page.html" onclick="foo()">…
```

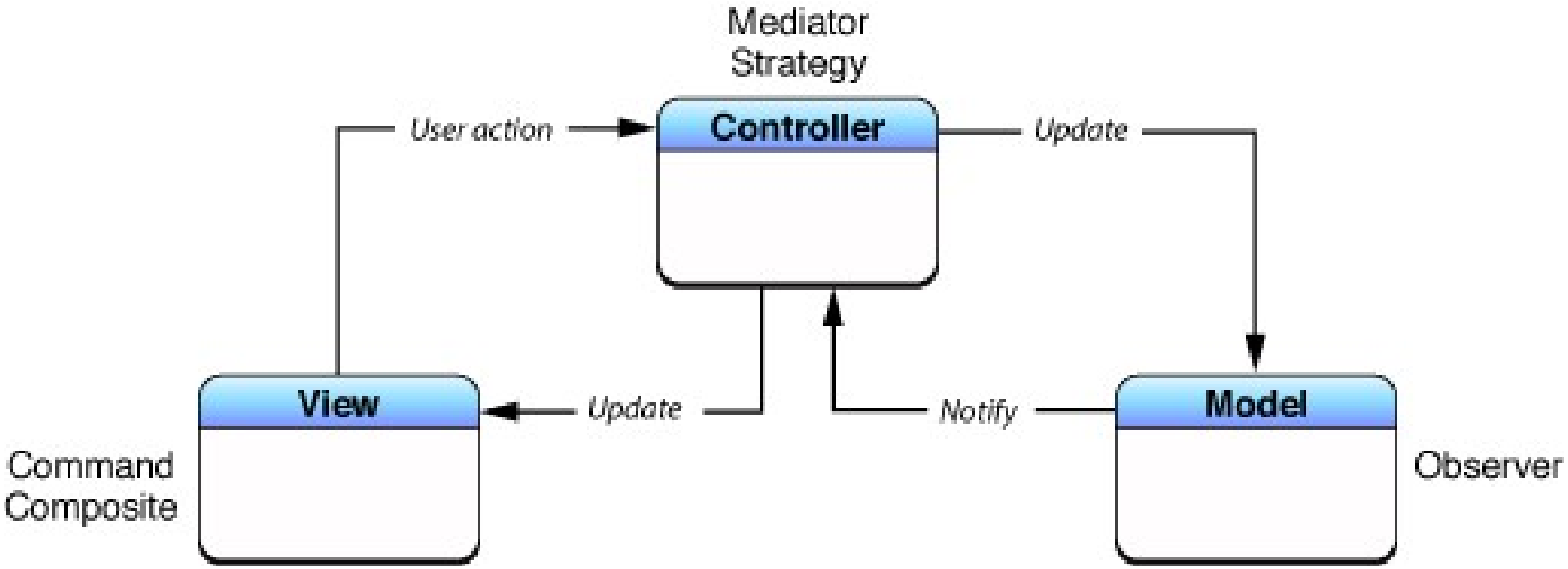
2. Direct (link in JavaScript)

```
var e = … //find source element in tree
e.onclick = foo;
```

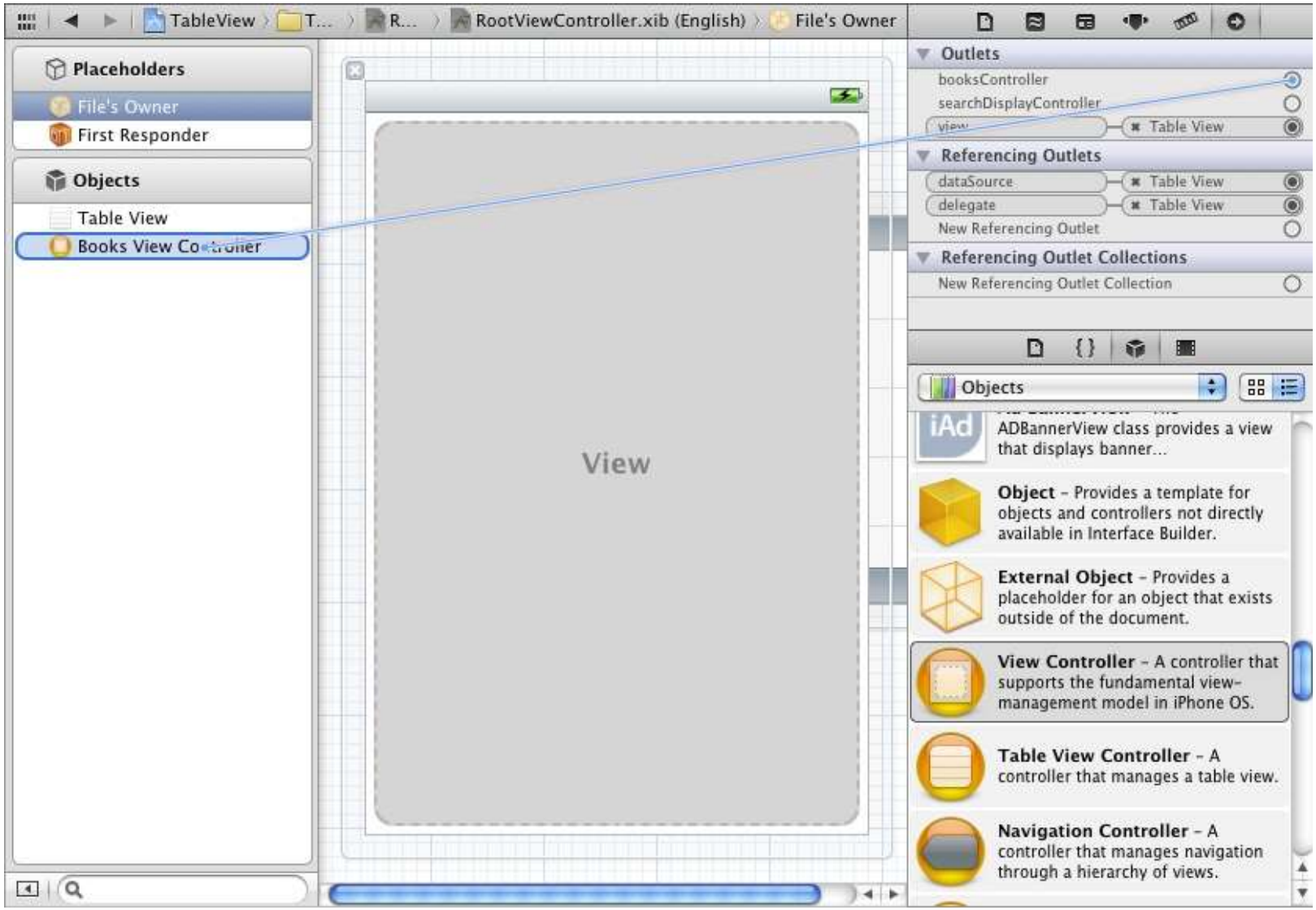
3. Chained (In JavaScript, browser differences)

```
var e = … //find source element in tree
e.addEventListener("click", foo, false);
```

Basic MVC in Objective-C



Implementing MVC in XCode



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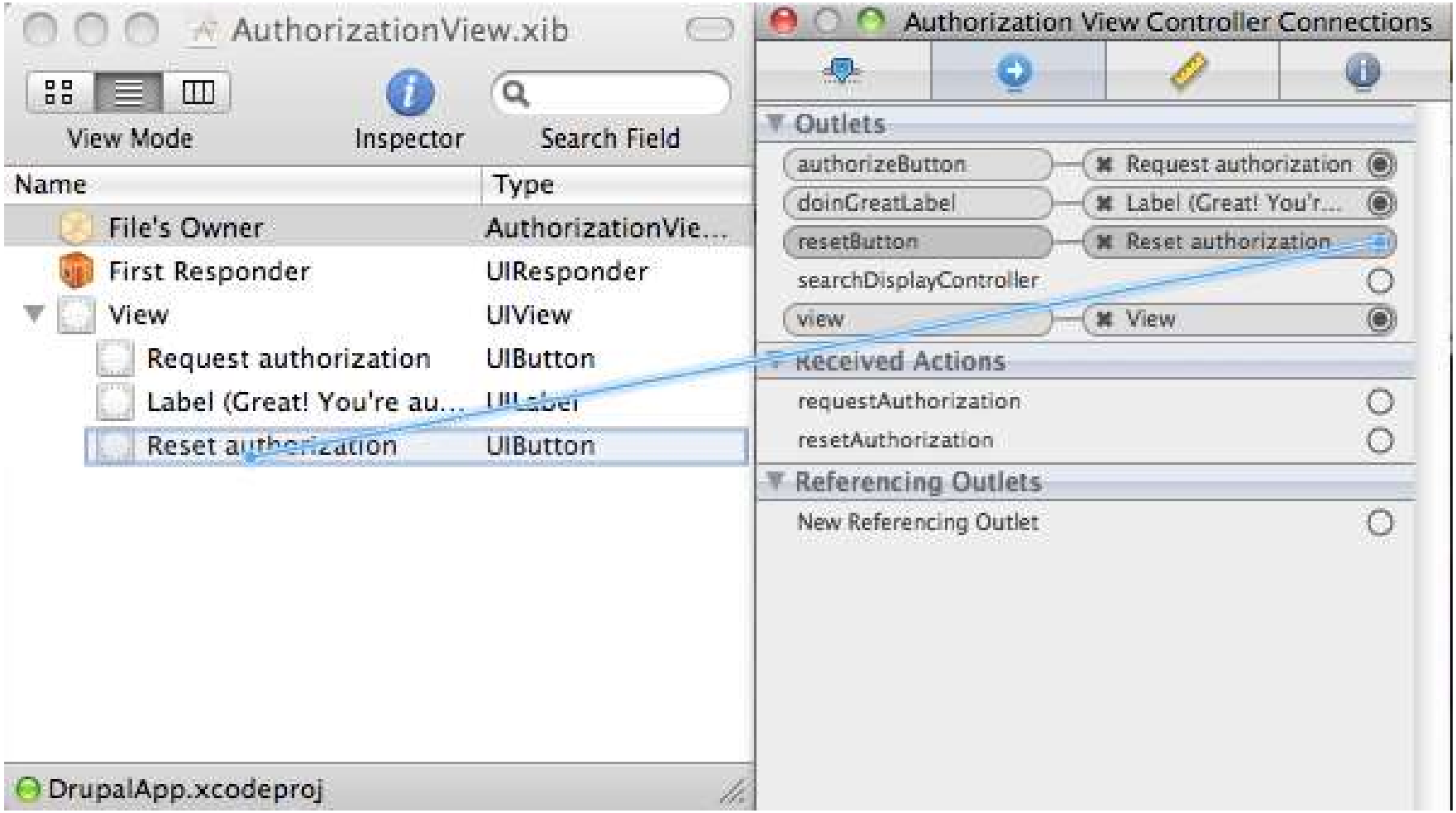
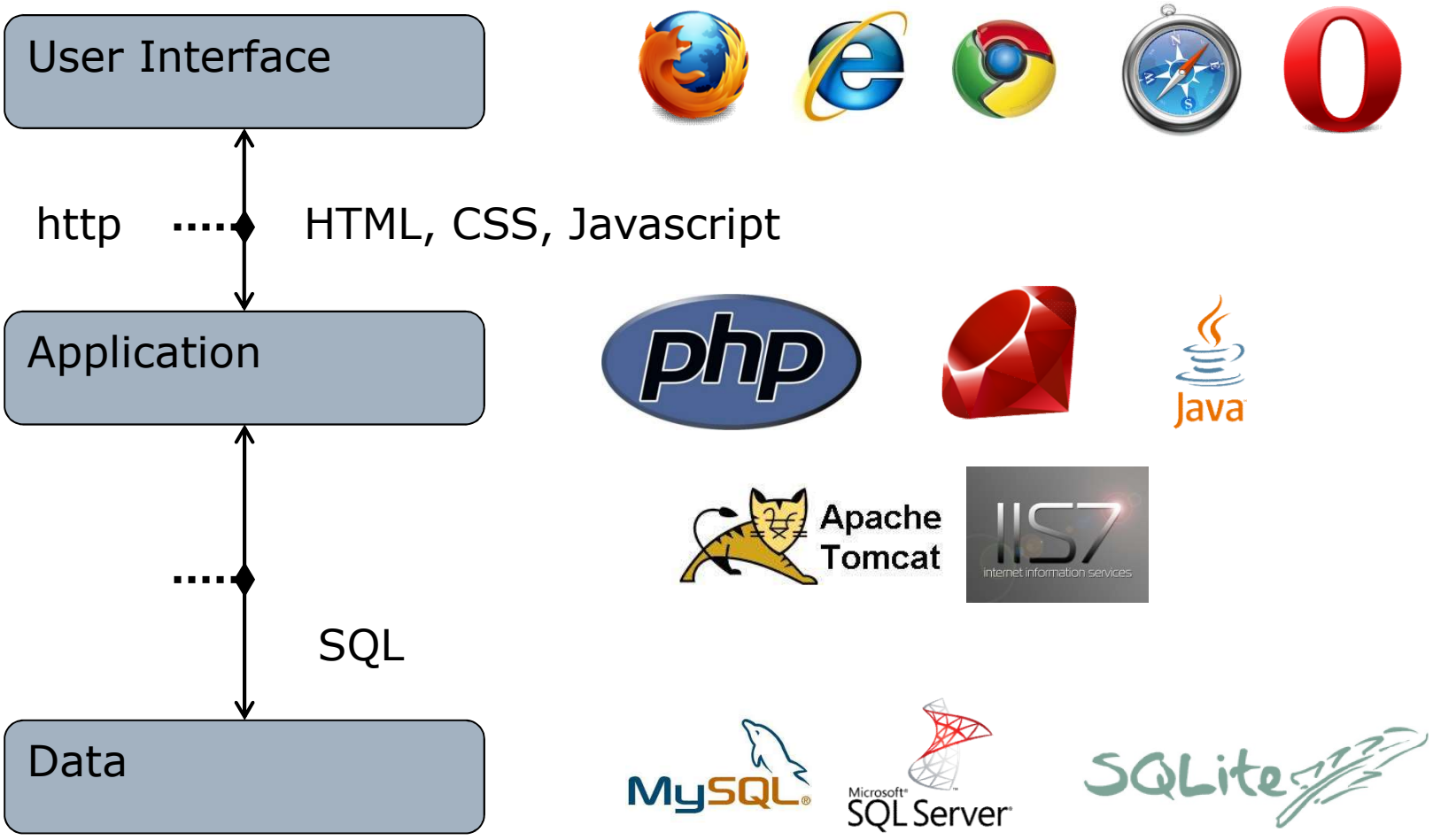


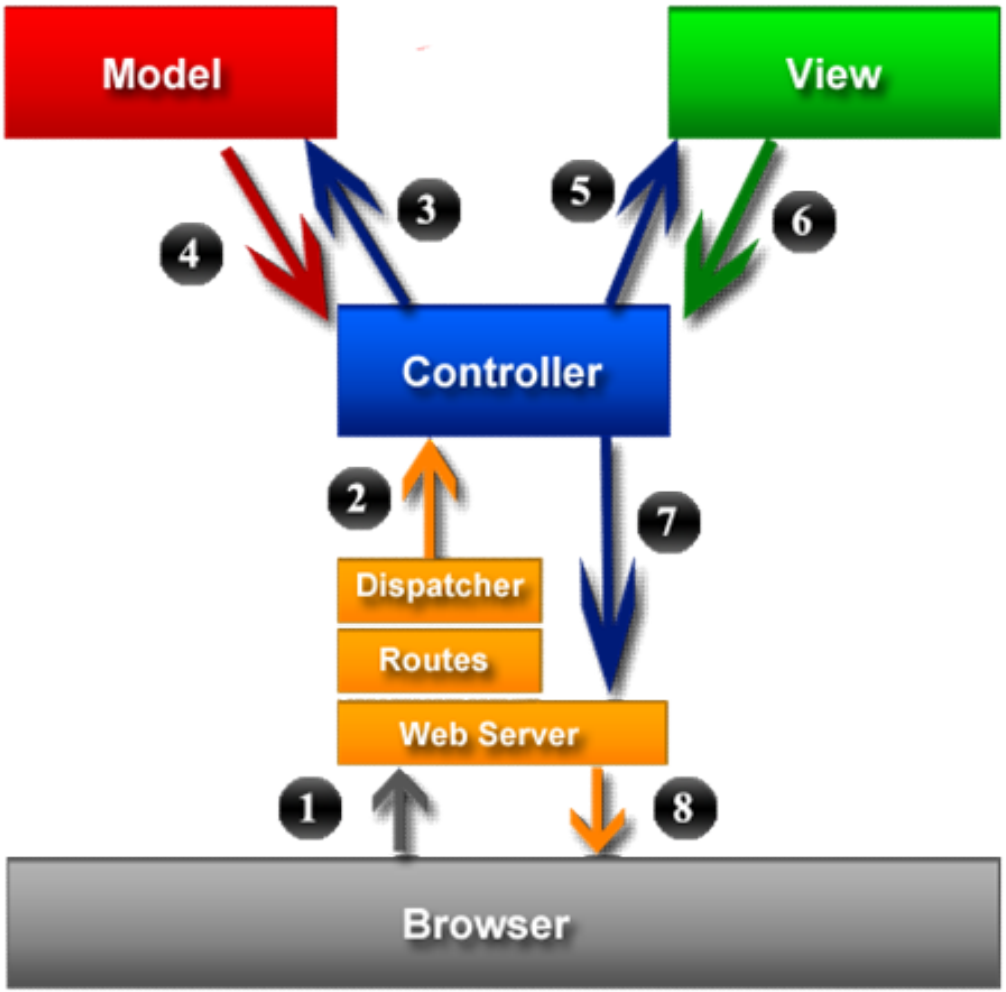
Basic Web App Skeleton: 3-Tier



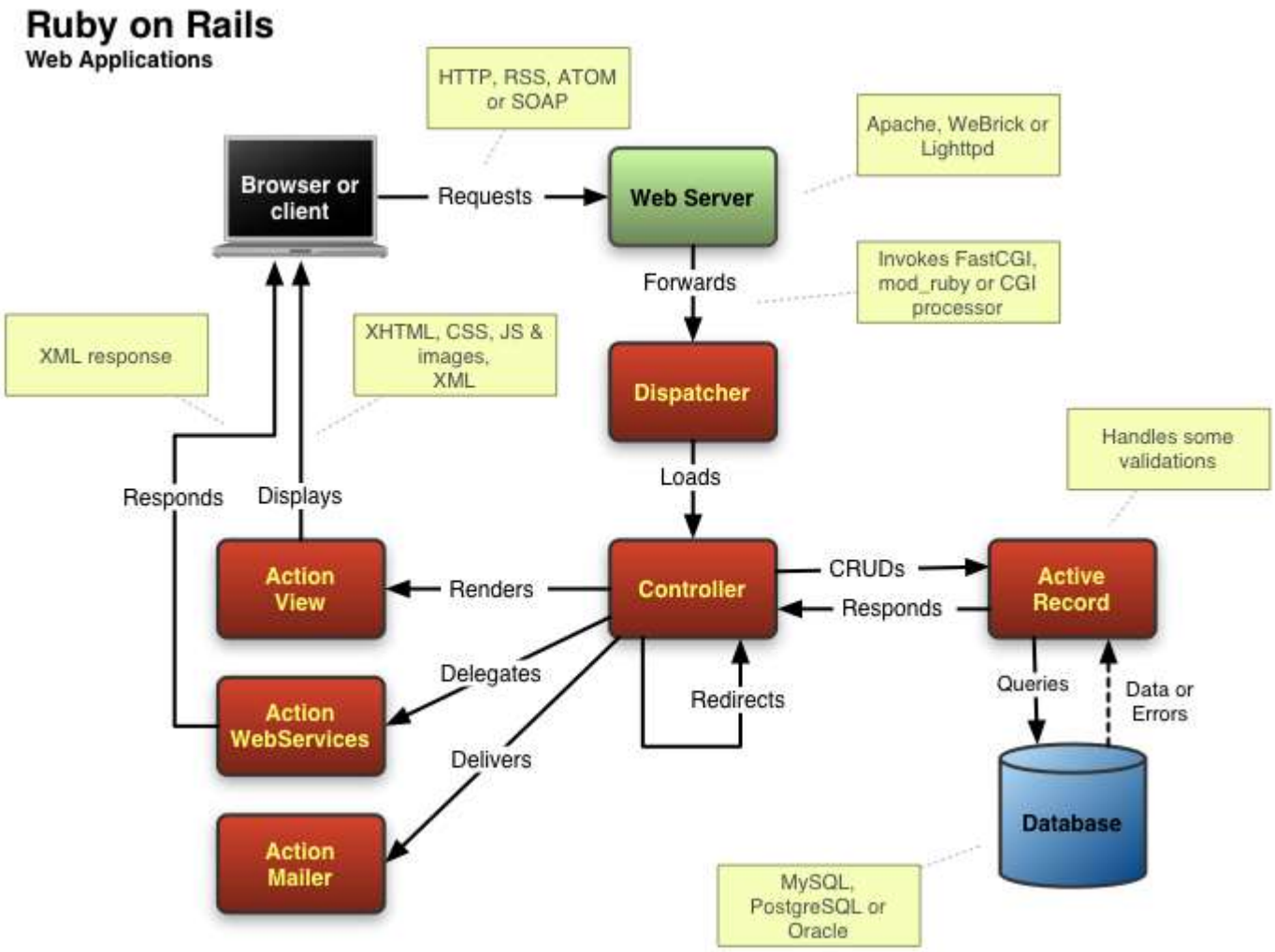
MVC in a Web Application

- Model
  - Database (table with rows)
  - Classes that wrap database operations (class with instances)
- View
  - HTML (+ CSS, JavaScript) files rendered by client's browser
  - Skeleton files used by server to generate these HTML files
- Controller
  - Receives HTTP requests via web server
  - Orchestrates activity (model and view)

MVC with Rails



MVC with Rails



Directory Structure of Rails


```
depot/
..../app
........./controllers
........./helpers
........./models
........./views
.............../layouts
..../components
..../config
..../db
..../doc
..../lib
..../log
..../public
..../script
..../test
..../tmp
..../vendor
....README
....Rakefile
```

"Convention Over Configuration"

- Use naming & location conventions to wire components together *implicitly*
- Explicit routing too, based on *names* and pattern matching
- Contrast with:
  - Configuration files (*e.g.*, XML)
  - Configuration code (*e.g.*, Swing register listener)
  - Configuration tools (*e.g.*, IDEs to connect GUI widgets to code snippets)

Wiring Parts Together in Rails

- Example: Event → Controller wiring
  - HTTP GET request for URL /say/hello gets routed to controller:
    - Class called `SayController`
    - File `say_controller.rb` in app/controllers
    - Method `hello`
- Example: Controller → View wiring
  - HTTP response formed from:
    - File app/views/say/hello.html.erb
- Example: Model → Database wiring
  - Class `Order` maps to database table "`orders`"
  - Attributes of `Order` map to *columns* of table
  - Instances of `Order` map to a *rows* of table

Summary

- Programming Patterns
  - Common idioms for solving categories of problems
  - Example: Observer pattern, MVC
- Separation of concerns
  - Decouple state from business logic
  - Decouple business logic from display
- Rails: Convention over configuration
  - Parts are wired together based on naming and structuring conventions
  - Defaults can always be overridden (but better not to fight!)