Advanced Web Development

Siddharth Kaza
Towson University, Computer and Information Sciences

Outline

- Web Dev Fundamentals/History
- Architectural Styles
  - Layered design - Model-view-controller
  - Deployment architecture - *n*-tier deployment
- Rails Demo
  - Introduction to our VM, IDE, and Rails environment
- MVC in other languages/environments
- Discussion on project topics and teams
  - Previous projects
- Lab 1 – First Rails project

Web Dev Fundamentals

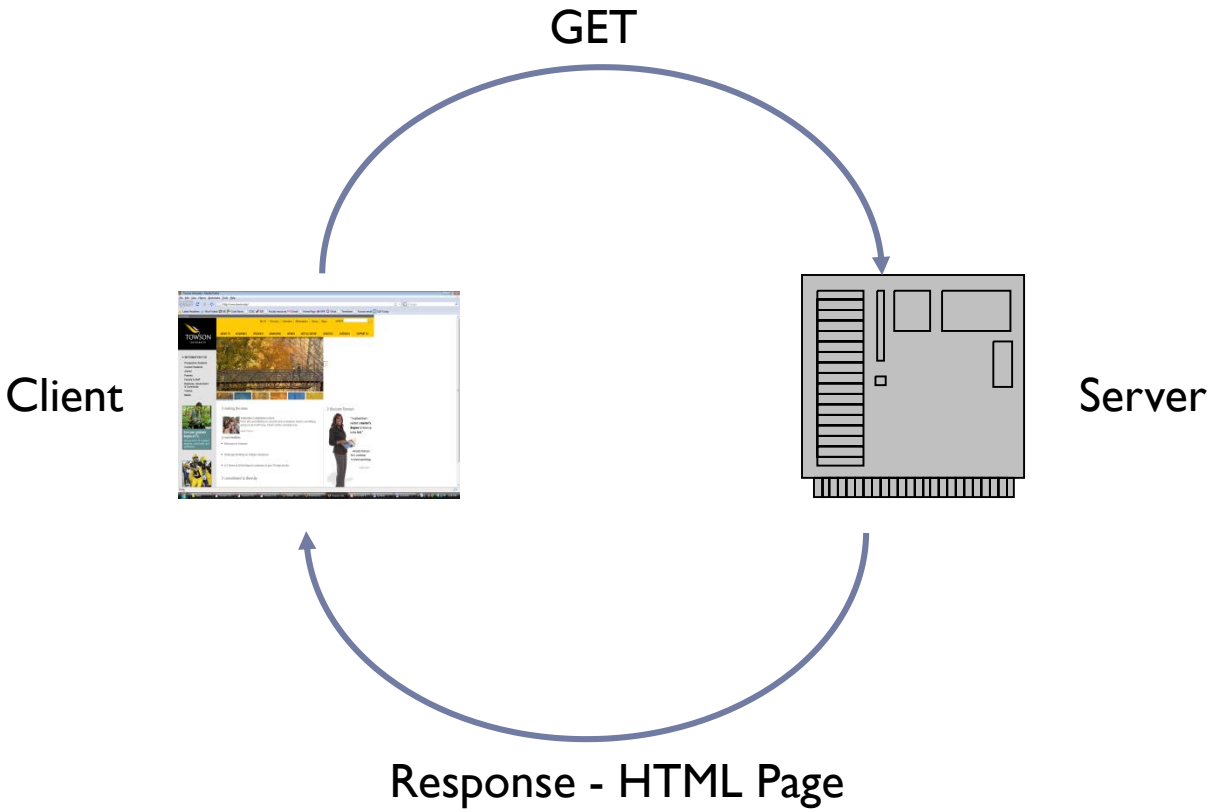
- Hypertext Markup Language (HTML) and Hypertext Transfer Protocol (HTTP)

- HTML – markup and structure
  - What's on a page and where
  - Content and layout
  - Links to other pages
  - Static content stored in files on fileserver

- HTTP
  - Protocol for transfer of information (web pages included)
  - Various methods: HEAD, GET, POST, DELETE, PUT

Original Web Application

Client/Server Deployment Design

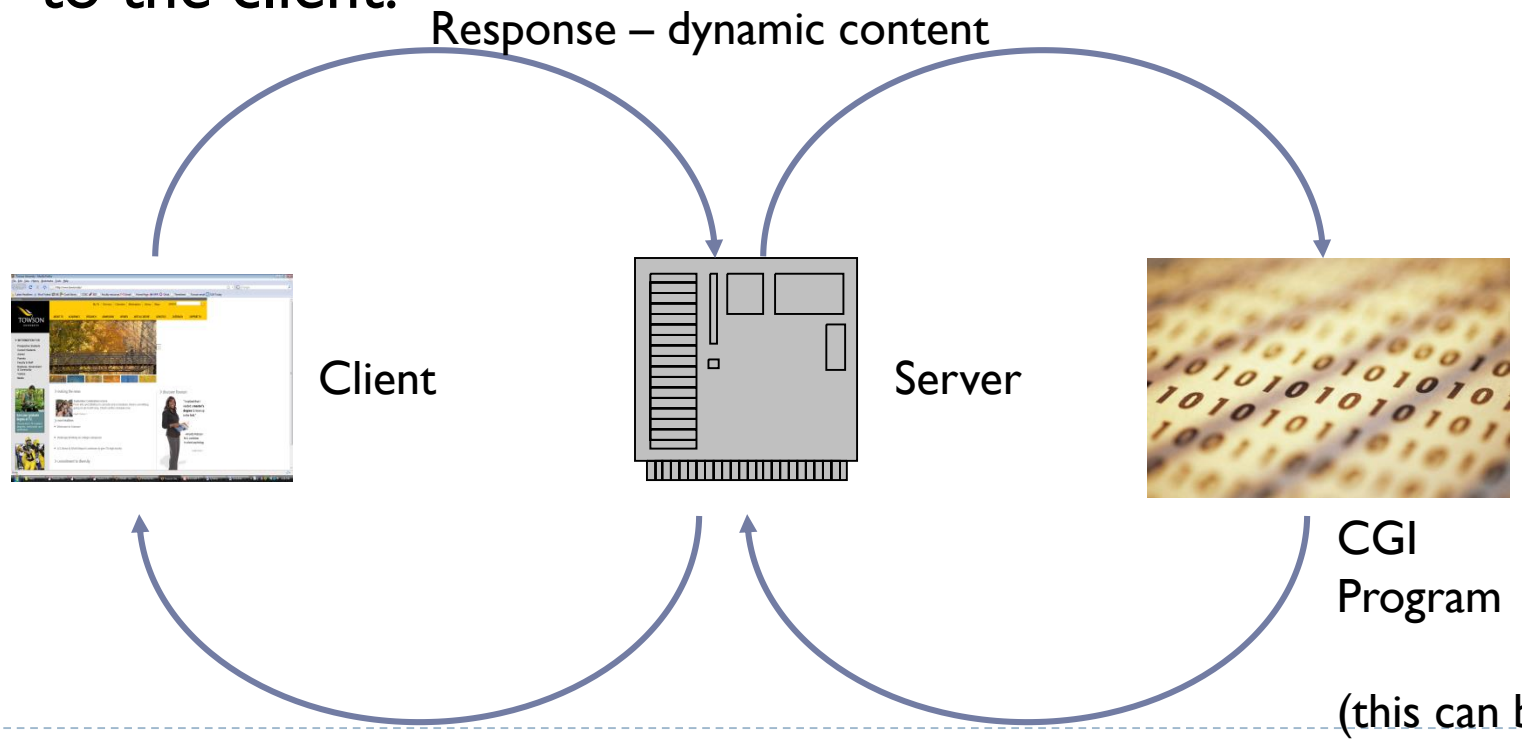


What's wrong with this?

- Static content gets boring.
  - Need to respond to user input
  - Generate content that is timely?
- HTML is limiting
  - Both layout and content
- User interaction is not sufficiently powerful
  - Need scripting on user side to make things interesting
- Full page request and response is clunky and slow

Beyond Static Content: Common Gateway Interface

- Instead of returning a static web page,
- Web server runs a program
- This program prints out HTML , which is then returned to the client.



- Three Tier Deployment Design

CGI Examples

- From:
  - http://inconnu.isu.edu/~ink/perl_cgi/lesson1/hello_world.html

```
#!/usr/bin/perl
print "Content-type: text/HTML\r\n\r\n";
print "<HTML>\n";
print "<HEAD><TITLE>Hello World!</TITLE></HEAD>\n";
print "<BODY>\n";
print "<H2>Hello World!</H2>\n";
print "</BODY>\n";
print "</HTML>\n";
exit (0);
```

  - What are the advantages? drawbacks?

HTML form elements

- Forms are almost a must for dynamic content
- Good reference (and source of these examples):
  - http://www.fincher.org/tips/web/SimpleForm.shtml

```
<FORM action="http://host/resource" method="GET">
..
</FORM>
```

- Method is "get" if request has no side-effects
  - Database is not modified, etc.
  - Example: read a blog entry
- Otherwise "POST"
  - Example: post a comment in response to a blog entry

HTML form elements (cont.)

- Short text field: text

```
NAME: <input type="text" name="name"
value="default" size="20" maxlength =
"20">
```

- Longer text block

```
Text Area:
<textarea cols="40" rows="6"
name="comments"></textarea>
```

Evolution of CGI

- Add databases on the back end
  - Store persistent data
  - Shopping carts, etc.
- Faster processing
- Templating languages for embedding code in HTML
  - PHP, Javascript, Embedded Ruby, ASP.NET
- Cookies for managing user state across requests
  - HTTP is "stateless" otherwise. Each request is independent of predecessors.

Databases

- Assume data for web systems is stored in a RDBMS
  - MySQL, Postgres, SQL Server, Oracle, etc.
  - This assumption may not be true because of cloud storage
- SQL for queries, data definition, etc.
- Frameworks like Ruby on Rails abstract details of data model
  - Bridge between underlying storage/retrieval tools and web system
  - Object-Relational Mapping
  - ActiveRecord (RoR), LinQ (.Net), Entity framework (.Net), Hibernate (Java) …
    - http://en.wikipedia.org/wiki/List_of_object-relational_mapping_software
- Other alternatives possible
  - XML, RDF
  - Storing in the cloud (Amazon Simple DB etc.)

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Architectural style in web applications

- Like any other complex structure, web apps must be built on a solid foundation.
- Failing to consider key scenarios, failing to design for common problems, or failing to appreciate the long term consequences of key decisions can put your application at risk.
- So we define architectural styles — a coarse grained pattern that provides an abstract framework for a system.

https://msdn.microsoft.com/en-us/library/ff650706.aspx

Key design principles

- **Separation of concerns:** Divide your application into distinct features with as little overlap in functionality as possible.
- **Single Responsibility principle**: Each component should be responsible for only a specific feature or functionality, or aggregation of cohesive functionality
- **Principle of Least Knowledge:** A component should not know about internal details of other components

https://msdn.microsoft.com/en-us/library/ff650706.aspx

Key Design principles

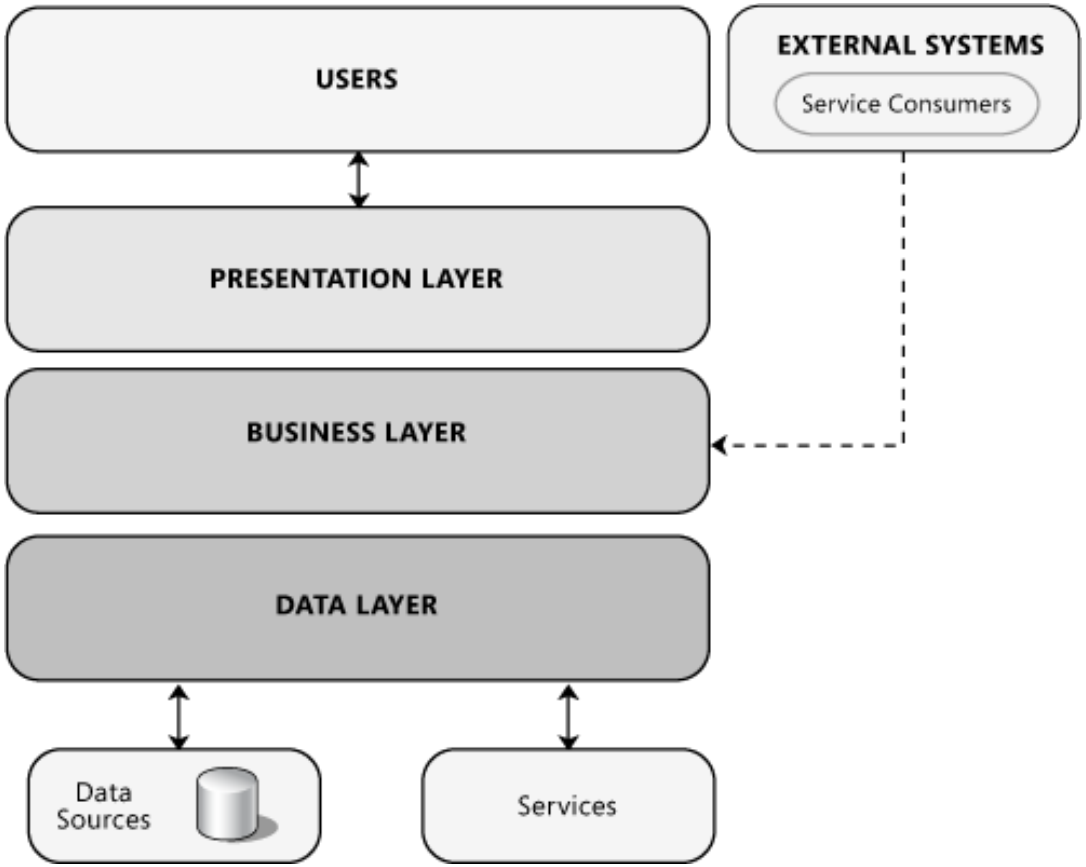
- **Don't repeat yourself (DRY).** You should only need to specify intent in one place.

- **Minimize upfront design.** Only design what is necessary upfront. If your application requirements are unclear avoid making a large design effort prematurely
  - avoid big design upfront (BDUF)
  - YAGNI ("You ain't gonna need it")

- https://msdn.microsoft.com/en-us/library/ff650706.aspx

Layered Design

Presentation – Business – Data Layer



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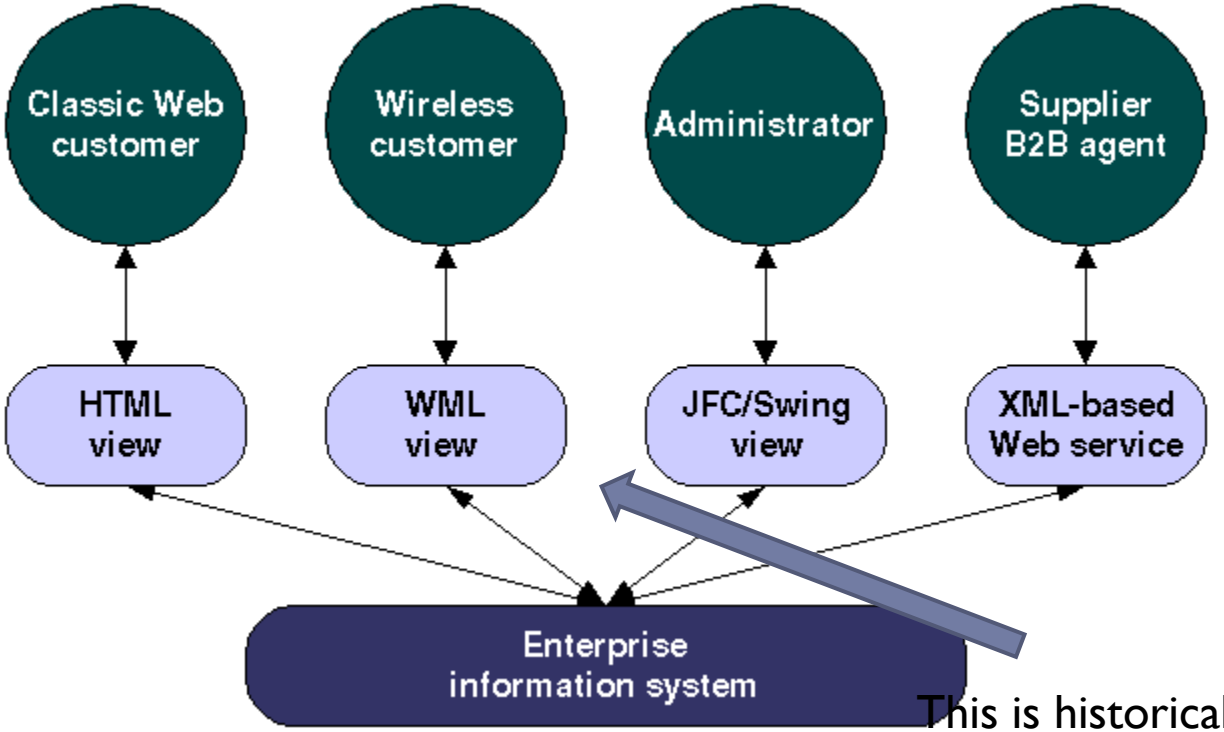
Model-View-Controller: Motivation

- Object oriented design principals
  - One class per "concept"
  - Each class does one thing well
    - Minimize coupling
    - Separation between classes is clear
  - Support re-use, modification, etc.
- Make classes into components.
- MVC coined in 1979 for use in Smalltalk

MVC on the Web: Motivation

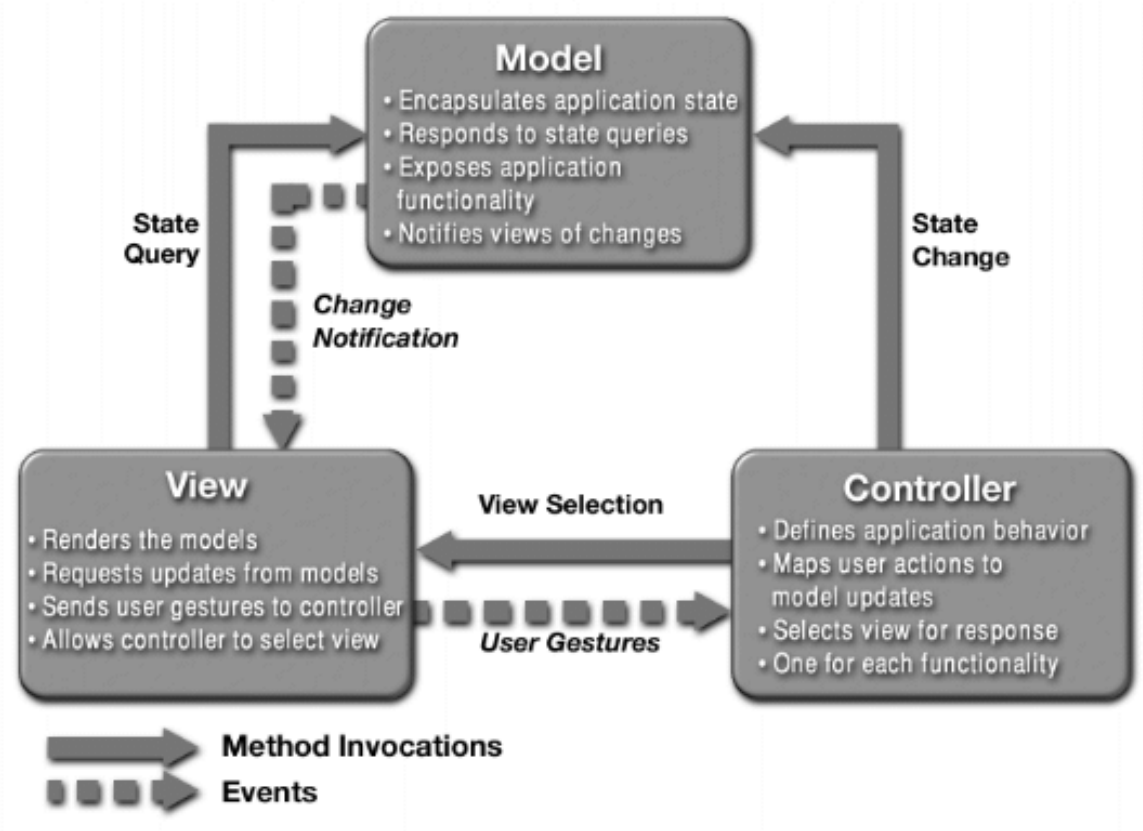
- Enterprises need to support multiple "views" of the same data



This is historical now, but you still need a mobile view.

- From: http://java.sun.com/blueprints/patterns/MVC-detailed.html

Sun's definition of MVC for Web



- From: http://java.sun.com/blueprints/patterns/MVC-detailed.html

Sun's definition of MVC for Web (cont.)

- Model: application data and rules.
  - "business logic"
- View: renders model. Gets data from model and specifies and presents it.
  - Views responsibility to show the most current data
- Controller: translates interactions with user into actions to be performed by the model.

- From: http://java.sun.com/blueprints/patterns/MVC-detailed.html

MVC and Rails

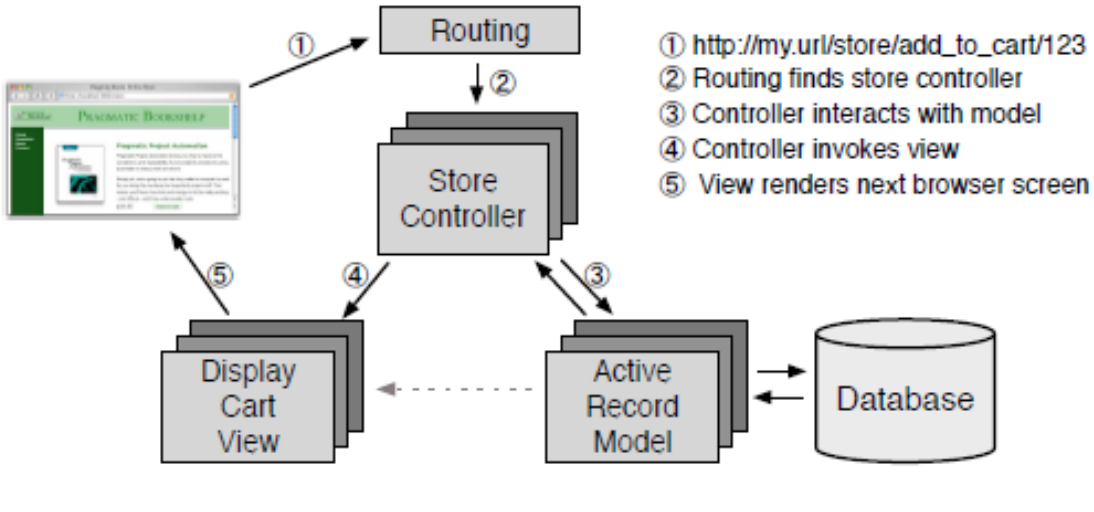


Figure 2.2: Rails and MVC

- So why use MVC?
  - Easier to develop, easier to maintain
  - Makes intuitive sense
- Why not?
  - 3x classes
  - Separation may not be clean

What's a model? What's a controller?

- Model – some object, or class of objects in a system or domain
  - **Nouns**
  - Maintains state of the application
  - Data + business rules

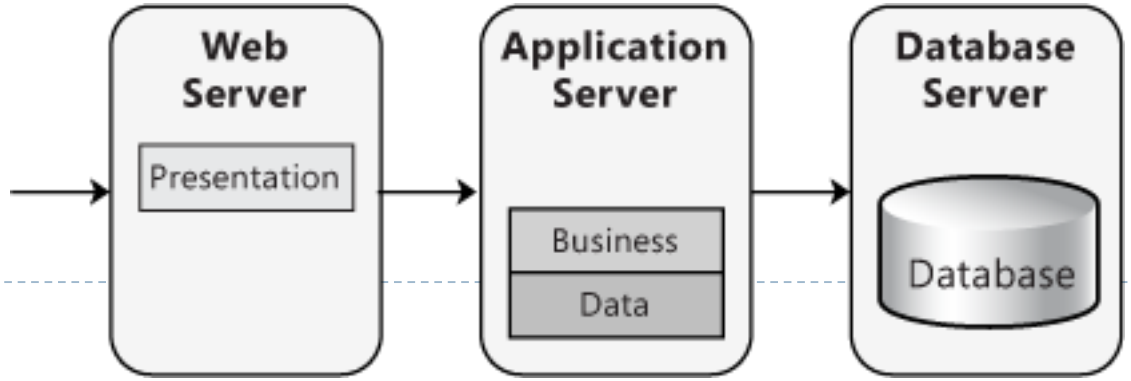
- Controller – collection of methods/actions that operate on a model
  - **Verbs**
  - Similar to methods in OO
  - Each model class has methods for setting and querying state
  - Verbs in controllers are things that web site might do to a model

Two types of models

- Persistent
  - Those things that we want to store for the long term in a database
  - User accounts
- Transitory
  - Information relating to the current session
- So don't think Models = DB Tables, it more than that
  - Classes
  - Arrays
  - Hashes

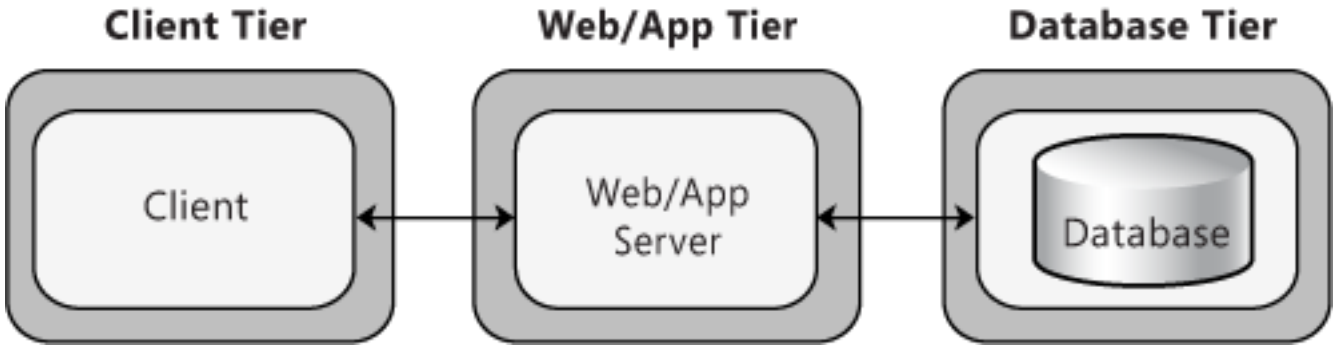
Deployment Architectures – *n*-tier

- Application architecture designs exist as models, documents, and scenarios.
- However, applications must be deployed into a physical environment where infrastructure limitations may negate some of the architectural decisions.
- In a distributed deployment, the layers of the application reside on separate physical tiers.

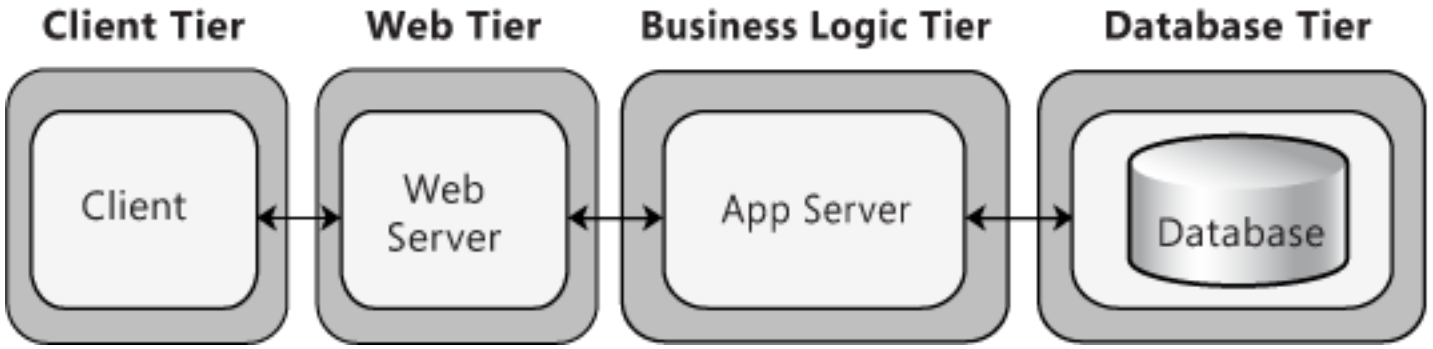


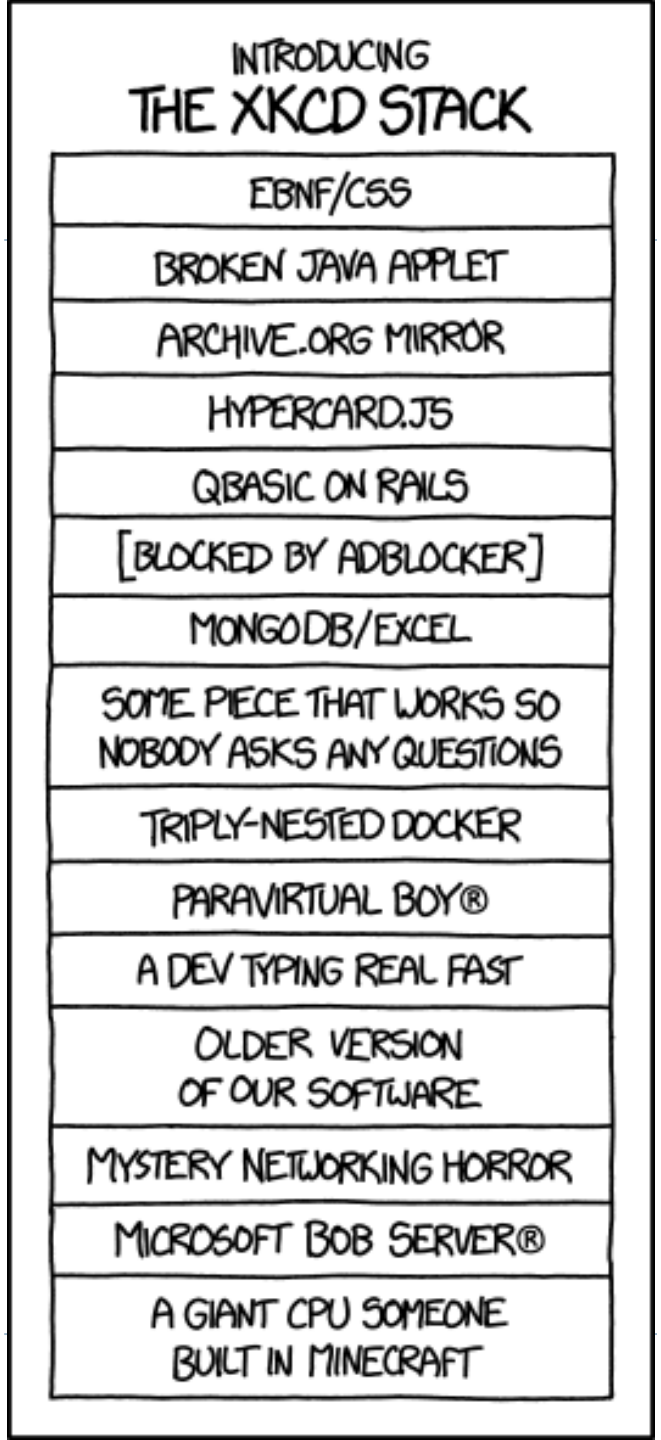
3-tier vs 4-tier

- Efficient – maybe not as secure



- More secure, balances load. Slower.





- https://xkcd.com/1636/

MVC and Deployment Design in Rails

- Lets do a small demo of rails
  - while we do this, think of MVC architecture and how it is manifesting itself

- A list of instructors and their courses.

Demo – Our VM

- The VM is Ubuntu 14
- Passwords on the blackboard in the VM document
- In the settings of VMWare Player/Workstation please assign your VM at least 3GB+
- Ruby 2.x, Rails >4.2.x, Rubymine
- Rails is a gem for Ruby along with other gems. So you install Rails after you install Ruby.
- It uses the Ruby Version Manager called rbenv
  - You may have to make sure that version manager is pointing to right version of ruby.
  - To check versions, use 'rails -v' and 'ruby -v'

- If you want to transfer files between your host machine and the VM, you may have to use a USB drive

Demo - Bundler

- One of the first problems you may face is certain dependencies missing
- Dependencies are gems that your application depends on to function
  - A gem is a packaged Ruby application or library. It has a name (e.g. **rails**) and a version (e.g. **3.2.8**).
- Very important to specify exactly which gems and what versions your application depends on
  - so it can function on servers with different S/W configurations
- The *bundler* takes care of this and installs gems that are missing.
  - See the Gemfile in your project folder
  - Add the lines to the file (if needed, mostly in windows)

    gem 'therubyracer'

    gem 'execjs'
    - Or uncomment it if its already there

Demo – actual app

- I will mostly go along with the book, but the application is slightly different.

- Steps
  - Generate a controller and views
    - rails generate controller main index goodbye time
  - Notice the directory structure and the structure of the controller file
    - See the link methods to views and how that functions
    - See routes.rb
  - See the URL structure
  - Add Course model
  - Link the main and the goodbye page together
  - To start the server
    - rails server
    - rake db:migrate

Demo

- Notice the Don't Repeat Yourself (DRY) and convention over configuration philosophies
  - Look at the size of the code vs. a Java-based application
- Initial impressions?
  - No complex configurations
  - Quick delivery of working software
  - Easy to test with the framework already in place
  - Code in many places, non-trivial to understand the first time
  - Ruby – the language is different, sometimes hard to understand

MVC in other languages/environments

- Various frameworks in Java – Tapestry, Struts, Spring,, Stripes
  - Nice introduction - https://struts.apache.org/birdseye.html
  - Hello World - https://struts.apache.org/docs/hello-world-using-struts-2.html
- .Net – ASP .Net MVC
- PHP – CakePHP
  - https://www.digitalocean.com/community/tutorials/how-to-create-a-small-web-application-with-cakephp-on-a-vps-part-1

MVC in Java : Model

```
package com.jbossatwork;

public class CourseBean {
        private String instructor;
        private String name;
        private int number;

        public CourseBean(String instructor, String name, int number) {
                this.instructor = instructor;
                this.name = name;
                this.number = number;
        }

        public String getInstructor() { return instructor; }
        public void setInstructor(String instructor)
                { this.instructor = instructor; }
...
}
```

- Code example modified from jbossatwork.com "JBoss at Work: A Practical Guide, by Tom Marrs and Scott Davis. Copyright 2005 O'Reilly Media, Inc., 0-596-00734-5."

MVC in Java : Controller

```
If (VIEW_COURSE_LIST_ACTION.equals(actionName)) {
        List courseList = new ArrayList();
        courseList.add(new CourseBean(“Kaza", "Intro", 236));
        courseList.add(new CourseBean(“Kaza",”Web”, 617));
        courseList.add(new CourseBean("Dierbach", "Intro", 175));
        request.setAttribute("courseList", courseList);
        destinationPage = "/courseList.jsp";
}
else {
        String errorMessage = "[" + actionName + "] is not a valid action.";
        request.setAttribute(ERROR_KEY, errorMessage);
}

// Redirect to destination page.
RequestDispatcher dispatcher =
        getServletContext().getRequestDispatcher(destinationPage);
dispatcher.forward(request, response);
```

- Code example modified from jbossatwork.com "JBoss at Work: A Practical Guide, by Tom Marrs and Scott Davis. Copyright 2005 O'Reilly Media, Inc., 0-596-00734-5."

MVC in Java : View

```
<body>
<ul>
<c:forEach items='${courseList}' var='course'>
<li> ${course.instructor}, ${course.name} ${course.number}</li>
</c:forEach>
</ul>

</body>
</html>
```

- Code example modified from jbossatwork.com "JBoss at Work: A Practical Guide, by Tom Marrs and Scott Davis. Copyright 2005 O'Reilly Media, Inc., 0-596-00734-5."

Ruby vs. Java versions

- Is it just a matter of dividing the code into pieces? What more does Rails give us?

- Model – similar
  - Ruby more concise.
  - Tools might generate Java setter/getter pairs for you

- View – almost identical

- Controller?
  - Boilerplate handled by Ruby with appropriate defaults
    - Error message
    - Message-handling
  - Dispatch
  - Most defaults can be over-ridden as needed.

Projects

- What are you thinking about doing?

- Examples: think about common sites that you see and plan to develop a scaled down version:
  - Ebay
  - Linkedin
  - Wikipedia
  - Twitter
  - …

Ruby

- Resources
  - Look at Lab 1
  - http://www.ruby-doc.org
  - Dave Thomas, et al. Programming Ruby, The Pragmatic Bookshelf.
    - Source of many of the examples in these slides
- Object oriented (no primitives like Java)
- Interpreted
- Code blocks "….end" delimited