Introduction to Web Application Development, for CS437/637

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Plan for course (more details on syllabus)

1. Introduction (today)
2. HTML (HTML5) and CSS using Duckett, HTML&CSS
3. PHP: using Murach & Harris (2ed or 3ed), PHP and MySQL
5. REST web services, using web resources

HW1: get started as soon as possible!

Introduction: Internet vs. World Wide Web

• Internet is an interconnected network of thousands of networks and millions of computers (sometimes called host computers or just hosts).
• The World Wide Web, or Web for short, is one of the Internet’s most popular services, providing access to over one billion Web pages.
• The Web runs over the Internet, using its ability to transfer data reliably (using TCP).

How the Internet evolved

• The Internet, then known as the ARPANET (Advanced Research Projects Agency Network), began in 1969, soon file transfers, emails were flowing.
• The current TCP/IP protocols date from 1983. The Internet was already international then, but restricted to non-commercial use.
• In 1990, it was opened to commercial use.…

A Hierarchy of Networks

• Every computer that is connected to the Internet is part of a network.
• You may use a cable or DSL modem to an Internet Service Provider (ISP). At work, you may be part of a local area network (LAN) using an ISP that your company has contracted with.
• When you connect to your ISP, you become part of their network. The ISP may then connect to a larger network and become part of their network. The Internet is simply a network of networks.

The architecture of the Internet
Luckily, the Internet can be viewed like this for our purposes...

### Internet Domain Naming System

- Provides unique ids for all the hosts directly connected to the Internet
  - Example hostname = www.cs.umb.edu, a unique hostname across the Internet.
- Domain naming system (in use since 1983):
  - Top-level domain name: edu
  - UMB's domain name: umb.edu
  - Departmental subdomain: cs.umb.edu
  - Full hostname = www.cs.umb.edu, specifying the departmental web server host
- The Internet's Domain Naming Service (DNS) servers translate a human-readable domain name into the machine-readable IP address.
  - The IP address of www.cs.umb.edu is 158.121.106.222, also unique across the Internet.

### The World Wide Web

- The Web runs over the Internet, using its ability to transfer data reliably (using TCP) and specify hosts with domain names and IP addresses.
- The crucial web protocol is HTTP (Hypertext Transfer Protocol)
- The Web dates from the early 90s.
- Since the Internet was already an international presence, so was the Web.

### Web Accessibility

- Web accessibility means that people with disabilities can use the Web.
- More specifically, Web accessibility means that people with disabilities can perceive, understand, navigate, and interact with the Web, and that they can contribute to the Web.
- HTML, especially HTML5, plays an important role by providing a standard way of describing what's on the screen.
- Our web apps will send HTML5 to our users, and so provide base-level accessibility.

### Uniform Resource Locator (URL)

- URLs specify locations on the Internet, along with the protocol needed for accessing something there.
- We say URLs specify "resources".
- A simple URL has the following format:
  <protocol> :// <hostname or IP address> / <path>
- Example: http://www.cs.umb.edu/cs637 (our class homepage)
  - Here hostname = www.cs.umb.edu
- Using IP address: http://158.121.106.222/cs637
- Alternative address, using topcat's webserver: http://topcat.cs.umb.edu/cs637/home

### What is a web application?

#### App vs. web app:
- An app (desktop or mobile) is a program that runs directly on the OS of the device.
  - Thus has sub-species: Android app, iOS app, Linux app, Windows app, MacOS app, etc., and each works only on its own OS.
  - An organization that wants all its users to use "its app" needs to implement all these versions.
- A web app runs inside a web browser. The web browser itself is an app on the desktop or mobile device.
  - Thus we would expect sub-species Chrome app, Safari app, Firefox app
  - But browsers are much more standardized than OSs, so we just say "web app" and expect it to run on any of these modern browsers.
  - An organization that wants all its users to use "its webapp" should only need to implement one version (possibly with some conditional code if using non-standardized features).
A web application has a website

- A web app pulls its pages, etc., from a website on a server connected to the Internet (or possibly a smaller network).
- A web app can accept user input and send it back to its server for processing (the PHP way), or process it right in the browser (the Javascript way).
- A web app depends on its server for saving data persistently.
- A web app UI is much like an app UI: buttons, forms, text input, etc., but may be slowed down by the network.

How static web pages are processed

- A static web page is a simple HTML file, no PHP or Javascript involved.
- HTTP is the network protocol that delivers HTML and many other data formats to the client web browser, including Javascript code.
- Note the web browser is very likely to be in a mobile device today, so this picture is a little dated.

One page can involve many HTTP requests

The response HTML* is carried by HTTP, itself carried by TCP, itself carried by IP

*HTML or CSS or Javascript code, also images, etc.

A simple HTTP request

GET / HTTP/1.1
Host: www.example.com

A simple HTTP response

HTTP/1.1 200 OK
Content-Type: text/html
Content-Length: 136
Server: Apache/2.2.3

<html>
<head>
<title>Example Web Page</title>
</head>
<body>
<p>This is a sample web page</p>
</body>
</html>

If this HTML text was just read from a file on the server, this is static HTML.
If a program helped generate it, it is dynamic HTML.
How dynamic web pages are processed with PHP

- The PHP code is not seen by the client, only the server-generated HTML.
- Any user click/taps cause another HTTP request to the server for processing.

Clients: Desktops and Mobile Devices

Similarities
- Both have rectangular hi-res color screens
- Both can accept keyboard input
- Both can accept click/tap selection of buttons, etc.
- Both can accept drag and drop selection of buttons, etc.
- Both can accept double-click, but this is almost never used in webapps, just in apps

- Based on these similarities, we want to be able to write webapps that run on both using the same codebase.

Javascript Execution Steps

1. User browses to something.html
2. Server sends HTML to the client, as we have just seen
   - In that HTML: link to URL for Javascript code
3. Browser finds link, does second HTTP request for Javascript (JS) code, again to a server.
   - JS code is loaded into browser memory
4. The JS code can detect load event, start executing to set things up for itself.
   - Can build more HTML elements, for example.
5. Later, when user clicks on something, it can be handled by JS immediately
   - No server involvement unless persistent changes are needed.

Key terms
- HyperText Markup Language (HTML)
- static web page
- HTTP request
- HTTP response
- dynamic web page
- PHP interpreter
- database server
- render
- round trip

Clients: Desktops and Mobile Devices

Differences
- Not all desktop screens are touch screens
- Can’t “hover” with touch screens
- Can’t “pinch” or “spread” with non-touch screens
- Other less common touch-screen gestures: long press, flick

- Using just PHP, we can’t detect any of these, or drag or double-click either, so we will concentrate on click/tap, and text input
- Using Javascript, we can detect the others...

Web browsers
- Chrome
- Firefox
- Internet Explorer/Edge
- Safari
- Opera

Web servers
- Apache
- IIS (Microsoft’s Internet Information Services)
Server-side languages
- PHP
- JSP
- ASP.NET
- Python
- Ruby

Client-side languages
- Javascript (can also run on server side)

PHP Advantages
- Considered easy to use, focuses on web
- Free, open-source (implemented in C)
- Provides decent performance
  - In particular, efficient with server memory use
- Available on many platforms

PHP disadvantages
- PHP strings are not in Unicode, so hard to provide non-English-language websites. (There are library calls for Unicode)
- "Too easy" so "lots of bad PHP exists", including insecure sites.
- Missing large-software features, like Java's package system.
- Not available for execution inside mobile platforms.
- Has no equivalent to JDBC, a widely supported generic database access API for Java. Most PHP webapps just use mysql.

Highlights in the history of PHP

<table>
<thead>
<tr>
<th>Version</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>1995</td>
<td>Personal Home Page</td>
</tr>
<tr>
<td>3</td>
<td>1998</td>
<td>PHP: Hypertext Processor</td>
</tr>
<tr>
<td>4</td>
<td>2000</td>
<td>Introduced the Zend Engine</td>
</tr>
<tr>
<td>5</td>
<td>2004</td>
<td>Introduced the Zend Engine II. Improved support for OOP. Added the PHP Data Objects extension</td>
</tr>
<tr>
<td>6</td>
<td>--</td>
<td>PHP6, meant to have native Unicode, abandoned</td>
</tr>
<tr>
<td>7</td>
<td>12/3/2015</td>
<td>Zend Engine 3, types for scalar arguments, 64-bit integer support on Windows, …</td>
</tr>
</tbody>
</table>

Note: we'll use version 5.6 on topcat (or 7 on XAMPP)

PHP vs. Javascript
- Javascript (JS for short) has become very important for web apps, especially ones that need to work nicely on smartphones.
- JS runs in the browser, so is closer to the user than PHP or Java, which run only on the server.
- JS can detect the advanced user gestures like pinch/spread.
- JS now can run on the server too, providing a single language for both sides.
- JS is a completely different language from Java or PHP, themselves in the same family. It does use Java-like syntax for conditionals, loops, etc.

Javascript and PHP
- Websites often use a combination of JS and PHP (or JS and Java).
  - The actions that need fast response to user requests, like game playing or device control, are in JS
  - Ancillary support, like changing a password, or documentation, are in PHP.
- The user often doesn’t know what language is in use.
  - Either language can do buttons, forms, links, etc.
  - But if there’s a bug running around the screen, that’s JS.
  - Or the restaurant menu folds up for you.
  - On the other hand, you don’t need JS for a photo carousel, so motion by itself doesn’t necessitate JS.

PHP Uses
- Small sites
- Prototypes for larger sites
- Server-side code for Javascript/Ajax running in web pages
- Server-side code for providing data for programs running in mobile devices
- Note no significant use inside mobile devices.
Database servers
- MySQL and its descendant MariaDB
- Oracle
- DB2
- MS SQL Server
- MongoDB (a No-SQL database)
- Apache HBase (also No-SQL, part of Hadoop project)

MySQL notes
- MySQL is owned and sponsored by MySQL AB, a for-profit firm.
- In 2008, Sun Microsystems acquired MySQL AB.
- In 2009, Oracle Corporation acquired Sun Microsystems.
- In 2009, many of the original developers of MySQL left MySQL AB and began working on different forks of the open-source code. One of the most popular of these forks is MariaDB.
- In 2012, tech writers reported that Oracle was holding back MySQL Server test cases and no longer synchronizing their changes with the public source repository. Also, several Linux distributions, Wikipedia and Google, began to replace MySQL with MariaDB.

XAMPP comes with MariaDB now, so we'll be using that on our development systems, and mysql itself on the Linux servers at cs.umb.edu.

MySQL highlights

<table>
<thead>
<tr>
<th>Version</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.23</td>
<td>1995</td>
<td>The original version of MySQL</td>
</tr>
<tr>
<td>4.0</td>
<td>2003</td>
<td>Introduced support for unions.</td>
</tr>
<tr>
<td>4.1</td>
<td>2004</td>
<td>Introduced support for subqueries and prepared statements.</td>
</tr>
<tr>
<td>5.0</td>
<td>2005</td>
<td>Introduced support for stored procedures, triggers, views, and transactions.</td>
</tr>
<tr>
<td>5.1</td>
<td>2008</td>
<td>Introduced support for row-based replication and server log tables.</td>
</tr>
<tr>
<td>5.5</td>
<td>2010</td>
<td>Default storage engine now supports referential integrity.</td>
</tr>
<tr>
<td>5.6</td>
<td>2011</td>
<td>Introduced support for big data.</td>
</tr>
</tbody>
</table>

We'll use MySQL version 5.6+, or MariaDB.

PHP derives lots of its syntax from C, so does Java... (but not Python)
- C-syntax control structures, increment operators
- But variable names in use are prefixed with $
- Java-type comments or // line comments

```php
// calculate the future value
$future_value = $investment;
for ($i = 1; $i <= $years; $i++) {
    $future_value =
        $future_value + ($future_value * $interest_rate * .01);
}
```

- Could rewrite last assignment, as in Java, with +=:

```php
$future_value += $future_value*$interest_rate*.01;
```

Hello World in PHP
- Source file hello.php:
  ```php
  <?php
  echo 'Hello World!';
  ?>
  ```
- Local execution: use php command
- Note no compilation step! It's a scripting language.
- Normal execution: put hello.php in right place for web server execution, say in c:\xampp\htdocs
- Browse to http://localhost/hello.php, see:

```
Hello World!
```

But PHP has differences too
- Good news! Associative Arrays
- C/Java: only integers can be used as array indexes
- PHP and other scripting languages:
  ✓ We can use strings as "keys" in array lookup!
  ✓ This includes Python, which has Dictionaries

PHP Example, pg. 321
```php
$tax_rates = array(); // or = [];
$tax_rates['NC'] = 7.75; // Akk!
$tax_rates['CA'] = 8.25; // Akk!

$payment = $price*$tax_rates[$state];
```
PHP is loosely, dynamically typed

$x = 12;  // an integer
$x = 2.3;  // now a double
$x = null; // now a null
$x = 'abc'; // now a string

• $x remembers its type, determined from the value on the rhs of the assignment.
• Good programming practice: types should be kept as static as possible
• Netbeans complains on multiple assignments to a variable, even of the same type values.

PHP is made for web apps

It maintains global arrays for easy access to HTTP request parameters, HTTP headers, session variables, and cookies.

Don't worry if this doesn't make sense yet!

It deallocates or saves away memory data after each request cycle is done, to minimize memory footprint. In other words, it assumes it is sharing the system with many other requestors.
A paragraph consists of one or more sentences that form a self-contained unit of discourse. The start of a paragraph is indicated by a new line.

Text is easier to understand when it is split up into units of text. For example, a book may have chapters. Chapters can have subheadings. Under each heading will be one or more paragraphs.

The moon is drifting away from Earth.

The Earth gets one hundred tons heavier every day due to falling space dust.

Note: `<br>` is the usual way to write the line break.
The Earth gets one hundred tons heavier every day due to falling space dust.

Beware: Pickpockets operate in this area.

I think Ivy was the first.
I think Ivy was the first.
I think Ivy was the first.

1. Chop potatoes into quarters
2. Simmer in salted water
3. Heat milk and butter
4. Drain potatoes and mash
5. Mix in the milk mixture

1kg King Edward potatoes
100ml milk
50g salted butter
Freshly grated nutmeg
Salt and pepper to taste

Sashimi
Sliced raw fish
Scale
A device used to accurately measure weight
**ORDERED LISTS (numbered)**

```
<ol>
  <li>Chop potatoes into quarters</li>
  <li>Simmer in salted water for 15-20 minutes until tender</li>
  <li>Heat milk, butter and nutmeg</li>
  <li>Drain potatoes and mash</li>
  <li>Mix in the milk texture</li>
</ol>
```

**RESULT**

1. Chop potatoes into quarters
2. Simmer in salted water for 15-20 minutes until tender
3. Heat milk, butter and nutmeg
4. Drain potatoes and mash
5. Mix in the milk mixture

---

**UNORDERED LISTS (bullets)**

```
<ul>
  <li>1kg King Edward potatoes</li>
  <li>100ml milk</li>
  <li>50g salted butter</li>
  <li>Freshly grated nutmeg</li>
  <li>Salt and pepper to taste</li>
</ul>
```

**RESULT**

- 1kg King Edward potatoes
- 100ml milk
- 50g salted butter
- Freshly grated nutmeg
- Salt and pepper to taste

---

**DEFINITION LIST**

```
<dl>
  <dt>Sashimi</dt>
  <dd>Sliced raw fish served with condiments.</dd>
  <dt>Scale</dt>
  <dd>A technique by which the scales are removed from the skin of fish.</dd>
</dl>
```

**RESULT**

- **Sashimi**: Sliced raw fish that is served with condiments such as shredded daikon radish or ginger root, wasabi and soy sauce.
- **Scale**: A technique by which the scales are removed from the skin of a fish.
<ul>
  <li>Mousses</li>
  <li>Pastries
      <ul>
        <li>Croissant</li>
        <li>Milles-feuille</li>
        <li>Palmier</li>
        <li>Profiteroles</li>
      </ul>
  </li>
  <li>Tarts</li>
</ul>