Computer Science 50 | Week 8 Wednesday: October 26, 2011
Fall 2011 | Andrew Sellergren
Scribe Notes

Contents

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1 Announcements and Demos (0:00–24:00)

- It's Final Project season! The Pre-Proposal is due Monday, 11/7. It's as easy as sending an e-mail to your TF outlining your ideas. Don't worry, these ideas can change considerably between now and when the project is due! You're not locked into anything.
- Take part in the CS50 Seminars if you have a desire to learn some technology that is beyond the scope of lecture. Register here.
- A number of APIs (Application Programming Interfaces) are available for your use in the Final Project and beyond. These APIs are libraries of code that allow you to work with datasets like the Harvard course list or implement features like sending text messages or e-mails without having to reinvent the wheel.
- In Problem Set 5, we asked you to critique technologies you've seen in the real world. Some of your feedback is excerpted here:
  - "All is good!"
  - "With all due respect, the current system of study-cards could be improved in my opinion..."
  - "The elevator in Mather house. Everyone always takes it from the rst oor to the fourth, and it always stays there because almost nobody takes it to go to the rst oor. Everyone always has to wait on the rst oor for it to come down. It should be programmed to go to the rst oor automatically after say, a minute or non-use.!"
  - "Turning on the TV in the Canaday common room actually is quite difcult. Not as easy as the click of a button. Why are there so many buttons? It is so confusing. I wish there could be two remotes - one with all the features and one with the basic functions like on and off, volume and channel changing. Perhaps button size on the remote could be different to denote importance. 'Wait, do i need to access the dvd player right now? no! I want to watch food network!' I'd love the on button to be big and 'play' dvd to be smaller, or more logically organized."
  - "The CS50 appliance could use one feature/improvement. A bigger screen. I have tried changing the screen size and resolution within the appliance, and it is buggy and doesn't scale up properly... Perhaps there is a trick for changing the size without a buggy result, and I don't know about it. If so, I would love to know! I would love to have a bigger screen! The speed is alright, but sometimes I wish I could just use my Mac to code everything up, I do love my 'textWrangler' and 'Xcode', however an improved screen size would ease most of my anxieties."

The fix for the screen resolution of the Appliance, by the way, is to install guest additions. A full breakdown of your Harvard-related critiques is available here. Some common themes are MyHarvard, pre-term planning tool, dining services, plan of study, and sectioning.

- If you've ever wondered how the internet really works, you should pay close attention to this video from Warriors of the Net which explains it in detail. We talked briefly last week about TCP/IP, which mandates that every computer on the internet have an IP address so that it can be uniquely identified when sending packets. One thing we didn't talk about is that TCP/IP guarantees delivery: if a packet is lost or otherwise fails to reach its destination, it will be resent. TCP/IP also allows servers to handle multiple services at once (e.g. mail, web, instant messaging) by including in each packet a port number in addition to a destination IP address. The default port numbers for web, e-mail, secure web, SSH, and FTP are 80, 25, 443, 22, and 21, respectively. These port numbers afford network administrators a very easy way to block certain traffic. Harvard, for example, seems to disallow traffic on the particular port number used for Wii network access.[1] A few questions related to this video:
  - Question: are packets really recycled? No. More properly, they're just created anew, the bits aren't really reused.
  - Question: what is a ping of death? A ping of death is a special type of ECMP packet that has more bytes than it's supposed to. In the old days,[2] a packet such as this was often enough to cause a web server to crash.

2 More with HTML (24:00–58:00)

2.1 From Last Time

- Last time, we began our foray into web development by creating a directory named `public_html` and making it executable by the world. We placed in this directory a file named `index.html` which contained some HTML that created a rather ugly web page. At the top of this file, there was a doctype declaration indicating that we're using version 5 of HTML. Following that declaration, we had a series of tags, beginning with the `html` tag which enclosed everything. Some tags, such as `body`, can have attributes associated with them. We defined the background color of our web page using the `bgcolor` attribute of `body`.
- One tag we introduced was the `div` tag which allowed us to divide our page into separate buckets of content. We were able to specify the `style` attribute of each `div` in order to dictate how it would display upon rendering. For example, we used `color: red` to make the text color of this

[1] Much to David's dismay, since all he does is play Wii Tennis.
[2] Like when David was in his twenties.

div red. This name-value pair was actually an example of a CSS (Cascading Style Sheets) property. In the early days of the web, the only way to style a web page was with attributes like `bgcolor`, which were often interpreted differently by different browsers. CSS, a language used specifically for styling, helps standardize the aesthetics of web pages.

- Recall that `<br>` was a so-called empty tag because it is opened and closed with a single tag. There's no need to write `<br></br>`, although it's technically still correct to do so.

- If you want to validate your web page, that is, check that its HTML is correctly formatted, you can copy and paste your source code into validator.w3.org. You can also validate by URL or file upload.

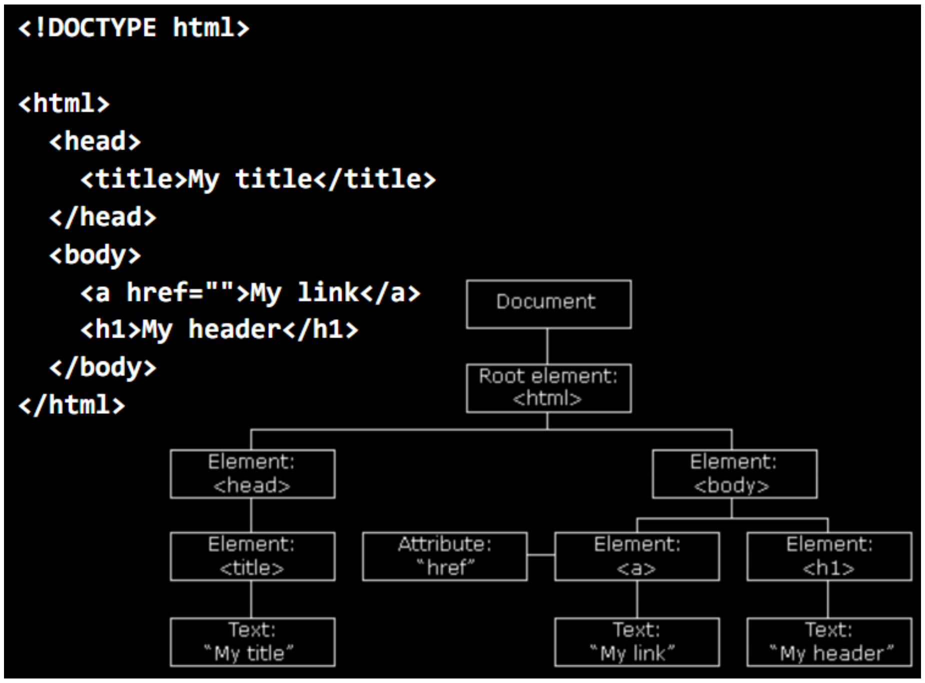
- To include links on your web page, you can use the `a` tag like so:

```
<!DOCTYPE html>
<html>
  <head>
    <title>My title</title>
  </head>
  <body>
    <a href="">My link</a>
    <h1>My header</h1>
  </body>
</html>
```

  The `href` attribute determines where the link points. Here we also demonstrate the use of the `h1` tag, which defines a standard heading style with large, bold font.

2.2 DOM

- The nesting of HTML tags defines a hierarchy of elements. The `head` and `body` elements are *children* of the `html` elements because they are nested within it. The `a` and `h1` elements are children of the `body` element. In fact, "My header" is a child of the `h1` element, albeit a textual one. The hierarchy of HTML elements can be visually represented as a tree:



```
<!DOCTYPE html>

<html>
  <head>
    <title>My title</title>
  </head>
  <body>
    <a href="">My link</a>
    <h1>My header</h1>
  </body>
</html>
```

At the top of the tree is a Document node which encompasses everything. The root element of the tree is the `html` element. We've drawn the `href` attribute on the same line as the `a` element because it's not really a child. Given this tree structure of HTML, more properly called the DOM (Document Object Model), the actual elements of a page are accessible using JavaScript, as we'll see in the coming weeks. Consider the autocomplete feature of Google Maps. Even though the page doesn't refresh as we type, search suggestions are being made on the fly by communicating with Google's servers. This is done using JavaScript and more specifically, a technology called Ajax.

2.3 `link` and `script` Tags

- Before we move on, let's introduce two more tags that will help us organize the source code of our web page:

```
<!DOCTYPE html>
<html>
  <head>
    <link rel="stylesheet" href="styles.css">
    <script src="scripts.js"></script>
    <title>hello, world</title>
  </head>
  <body>
```

```
    hello, world
  </body>
</html>
```

The `link` tag is similar to `#include` from C in that it allows us to import a separate file, in this case a CSS file. Similarly, the `script` tag with a specified `src` attribute allows us to include a JavaScript file.

- If we right click to View Source on the course website, we see among a lot of mess the following tag:

  ```
  <link href="/css/styles.css" rel="stylesheet" type="text/css" />
  ```

  This tells us that some of the CSS for the course website is defined in a file named `styles.css` within the subdirectory `css`. We can view this file by navigating to `http://cs50.net/css/styles.css`. As an example of what's defined therein, take a look at these lines:

  ```
  /* should probably be renamed div#ohs */
  div#fyi
  {
      font-size: 77%;
  }
  div#fyi a
  {
      color: #0073AC;
      text-decoration: none;
  }
  div#fyi a:hover
  {
      text-decoration: underline;
  }
  ```

  These lines define rules for a `div` tag with the `id` attribute set to `fyi`, namely the section at the top of the course homepage which contains announcements. Once we had given some thought to what the default font size for the course website should be, we could define all the other font sizes relative to this. Thus, the font size of the `fyi` section is 77% of the default. The second set of curly braces above defines styles for any `a` tags that are within the `div` tag with `id` of `fyi`. We decided we wanted those to have a color of light blue (`#0073AC`) and not be underlined (`text-decoration: none`).

- Know that the ability to view the underlying CSS and JavaScript of a website is not limited to the course website. You can go to Facebook, for example, and peek at their CSS and JavaScript by following the URLs they include via the `link` and `script` tags. When you peek at their JavaScript, you'll notice that it's wholly unreadable. This is because they wrote it in a readable way and then obfuscated or minified it. Obfuscating or minifying JavaScript is a way of condensing it into fewer characters (e.g. by removing whitespace) to save bandwidth and making it harder to reverse engineer to protect intellectual property.

2.4 Implementing Google

- When we type in "Harvard" into Google, we are redirected to a very long URL that displays our results. If we take that long URL and throw away a lot of the information that isn't relevant to us, but only to the server, we get something like the following:

  `http://www.google.com/search?query=harvard`

  If you navigate directly to this URL, you will see the results for a search of "Harvard" even without all the other information in the URL. As you might have guessed, the string `q=harvard` in the URL designates our query as an input to some program on Google's server[3] that fetches results. Multiple key-value pairs can be specified in a URL so long as they are separated by ampersands (`&`).

- If we right click to View Source on Google's homepage, we see a whole lot of HTML, most of which isn't important to our discussion here. One interesting thing to note is the scalability concerns of all this HTML. If a programmer types an extra space by accident and that single space is downloaded a billion times over the course of user visits to Google in a single, that's a billion unnecessary bytes that Google's servers have transmitted.[4] An errant space could mean a lot of money lost!

- To clean up the mess of Google's HTML, we can use a tool called Firebug that is installed by default in Firefox on the Appliance. When we right click on the search query box on Google's homepage and select Inspect Element, we are presented with a window that displays the HTML in a much more readable format, as a hierarchical tree consisting of collapsible elements. One of these elements is a `form` tag which has an `action` attribute specifying where data is to be sent when the form is submitted. In this case, it has the value `/search`.

- The `form` element has multiple children, some of which are `input` elements. One of these `input` elements has an attribute `type` specified as `submit`. This particular `input` element implements the Submit button familiar to you from so many websites. Interestingly, Firebug allows us to muck with the HTML of a website, so we can click on the `value` attribute of the "I'm Feeling Lucky" button and change it so that it instead displays "I'm Feeling Unlucky."

[3]Yes, we only have one.
[4]One time, I introduced a slash into our source code and broke Google.

- Now that we know that the magic of Google is really in the `form` element, we can implement our own version of Google like so:

```
<!DOCTYPE html>

<html>
  <head>
    <title>CS50 Search</title>
  </head>
  <body>
    <center>
      <img src="search.gif">
      <br>
      <form action="http://www.google.com/search">
        <input name="q" type="text">
        <br>
        <input type="submit" value="CS50 Search">
        <input type="submit" value="I'm Feeling Lucky">
      </form>
    </center>
  </body>
</html>
```

  Using Google Logo Generator, we can create our own Google-esque logo. Don't forget to `chmod` it properly! Also note that our `action` attribute of the `form` needs to be a full URL pointing to Google, not simply `/search`. That's because the search program doesn't live on our server, but rather on Google's.

3 PHP (58:00–75:00)

3.1 `froshims1.php`

- `froshims1.php` mimics a site that David made years ago to help automate the process of registering for freshman intramural sports. There are form inputs for name, gender, captainship, and dorm. To lay out the form, we use an HTML table:

```
<?
    /*************************************************************
     * froshims1.php
     *
     * Computer Science 50
     * David J. Malan
     *
     * Implements a registration form for Frosh IMs.
     * Submits to register1.php.
     *************************************************************/
?>

<!DOCTYPE html>

<html>
  <head>
    <title>Frosh IMs</title>
  </head>
  <body>
    <div style="text-align: center">
      <h1>Register for Frosh IMs</h1>
      <br><br>
      <form action="register1.php" method="post">
        <table style="border: 0; margin-left: auto;
            margin-right: auto; text-align: left">
          <tr>
            <td>Name:</td>
            <td><input name="name" type="text"></td>
          </tr>
          <tr>
            <td>Captain:</td>
            <td><input name="captain" type="checkbox"></td>
          </tr>
          <tr>
            <td>Gender:</td>
            <td>
              <input name="gender" type="radio" value="F"> F
              <input name="gender" type="radio" value="M"> M
            </td>
          </tr>
          <tr>
            <td>Dorm:</td>
            <td>
              <select name="dorm">
                <option value=""></option>
                <option value="Apley Court">Apley Court</option>
```

```
                    <option value="Canaday">Canaday</option>
                    <option value="Grays">Grays</option>
                    <option value="Greenough">Greenough</option>
                    <option value="Hollis">Hollis</option>
                    <option value="Holworthy">Holworthy</option>
                    <option value="Hurlbut">Hurlbut</option>
                    <option value="Lionel">Lionel</option>
                    <option value="Matthews">Matthews</option>
                    <option value="Mower">Mower</option>
                    <option value="Pennypacker">Pennypacker</option>
                    <option value="Stoughton">Stoughton</option>
                    <option value="Straus">Straus</option>
                    <option value="Thayer">Thayer</option>
                    <option value="Weld">Weld</option>
                    <option value="Wigglesworth">Wigglesworth</option>
                  </select>
                </td>
              </tr>
            </table>
            <br><br>
            <input type="submit" value="Register!">
          </form>
        </div>
      </body>
    </html>
```

The `table` tag introduces a spreadsheet-type layout. If we wanted to make this table actually visible, we can set its `border` CSS property to a non-zero value. As it is, we're just using it to make sure things align properly.

- HTML forms can be submitted by one of two methods: GET and POST. Whereas GET transmits parameters via an addendum to the URL, POST transmits parameters via the HTTP headers. GET is slightly less secure because it is more readably visible, but it is also more convenient for creating persistent links for bookmarks. POST, of course, supports transmitting larger amounts of data (e.g. an image file) because URLs have a maximum length.

- We've implemented a radio button for the gender input by specifying `type="radio"`. We can then have multiple options for this input and they will be mutually exclusive (i.e. selecting one will deselect the others) so long as all of the `input` tags have the same `name` attribute.

- The `select` tag implements a dropdown menu. We can specify how many elements in the menu we want to show at a given time using the `size` attribute. Each `option` tag that falls inside of the `select` tag represents a choice in the dropdown menu. What is actually transmitted by the form is stored in the `value` attribute for each of these `option` tags.

- Although our page is a PHP file (hence the `.php` extension), what it outputs to the browser is nothing but HTML. Herein lies the power of PHP: it can be commingled with HTML seamlessly. Our approach to outputting the names of freshman dorms is quite inefficient as it is. What would be better is storing the list of dorms in a database and then querying for it at the time a user visits the page. We'll soon do this using PHP.

3.2 `register1.php`

- What happens to our form data once it's submitted? In the `action` attribute of our `form` tag, we specified `register1.php`. Let's take a look at its source code:

```
<?
    /***********************************************************
     * register1.php
     *
     * Computer Science 50
     * David J. Malan
     *
     * Implements a registration form for Frosh IMs.  Redirects
     * user to froshims1.php upon error.
     ***********************************************************/

    // validate submission
    if (empty($_POST["name"]) || empty($_POST["gender"])|| empty($_POST["dorm"]))
    {
        header("Location: http://localhost/~jharvard/froshims/froshims1.php");
        exit;
    }

?>

<!DOCTYPE html>

<html>
  <head>
    <title>Frosh IMs</title>
  </head>
  <body>
    You are registered!  (Well, not really.)
  </body>
</html>
```

PHP code is enclosed by `<?` and `?>`. When a web server is configured to recognize `.php` files, it will look for this source code on the server and then execute everything that's between these two tags.

- If we try to submit our form data without filling in all the inputs, we get bounced back to the first page. This is accomplished with the if condition at the top of `register1.php`. Because we've submitted form data using the POST method, all of that data is handed to us in a so-called superglobal variable named `$_POST`. This variable is actually a hash table or an associative array. In C, our arrays could only have numerical indices, but in PHP, we can have strings and many other types as indices as well. In this if condition, we're checking if any of the indices in `$_POST` have empty values associated with them. This would imply that the the user failed to fill in one of the inputs. If that's true, then we redirect him or her to `froshims1.php` using the `header` function which spits out HTTP headers.
- The HTTP header of importance in this case is the Location header, which is generally used for redirecting. We can see this header in action if we open Live HTTP Headers while visiting `google.com` (not `www.google.com`). Upon doing so, we see that an HTTP response with code 301 Moved Permanently is returned by the server. Then a second HTTP request is issued for `www.google.com`. Why? Perhaps for branding or technical purposes, it's not completely clear.

3.3 `register3.php`

- As a teaser for next time, work your way through `register3.php` which sends an e-mail with your registration information using only a few lines of code:

```
<?
    /***********************************************************************
     * register3.php
     *
     * Computer Science 50
     * David J. Malan
     *
     * Implements a registration form for Frosh IMs.  Reports registration
     * via email.  Redirects user to froshims3.php upon error.
     **********************************************************************/

    // validate submission
    if (!empty($_POST["name"]) && !empty($_POST["gender"]) && !empty($_POST["dorm"]))
    {

        $to = "malan@cs50.net";
        $subject = "Registration";
        $body = "This person just registered:\n\n" .
         $_POST["name"] . "\n" .
         $_POST["captain"] . "\n" .
         $_POST["gender"] . "\n" .
         $_POST["dorm"];
        $headers = "From: malan@cs50.net\r\n";
        mail($to, $subject, $body, $headers);
    }
    else
    {
        header("Location: http://localhost/~jharvard/froshims/froshims3.php");
        exit;
    }
?>

<!DOCTYPE html>

<html>
  <head>
    <title>Frosh IMs</title>
  </head>
  <body>
    You are registered!  (Really.)
  </body>
</html>
```