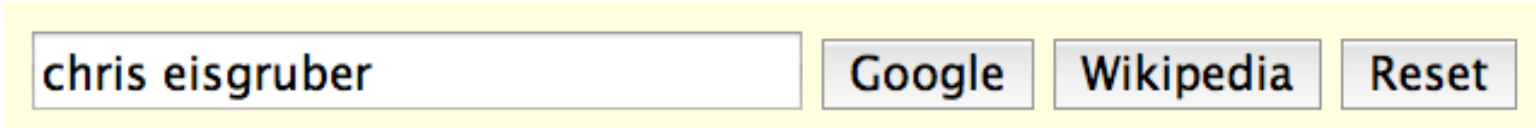
Lecture 8
Web Programming

DOM: Document Object Model

- browser presents an object interface
  - accessible from and modifiable by Javascript
- DOM entities have methods, properties, events
  - element properties can be accessed & changed
  - elements can be added or removed
- document object holds page contents
  - elements stored in a tree: HTML tags, attributes, text, code, ...
  - each element is accessible through the DOM
  - through functions called from Javascript
- page is "reflowed" (smart redraw) when anything changes

- window object also has methods, properties, events
  - alert(msg), prompt(msg), open(url), ...
  - size, position, history, status bar, ...
  - onload, onunload, ...
  - window.document: the document displayed

Basic events on forms




```
<head>
<script>
function setfocus() { document.srch.q.focus(); }
</script>
</head>
<body onload='setfocus();'>
<H1>Basic events on forms</H1>
<form name=srch
      action="http://www.google.com/search?q="+srch.q.value>
<input type=text size=25
       id=q name=q value="" onmouseover='setfocus()'>
<input type=button value="Google" name=but
    onclick='window.location="http://www.google.com/
                                search?q="+srch.q.value'>
<input type=button value="Wikipedia" name=but
    onclick='window.location="http://en.wikipedia.com/
                                wiki/"+srch.q.value'>
<input type=reset onclick='srch.q.value="" ' >
</form>
```

More examples...

- in a form:

```
<form>
 <input type=button value="Hit me"
    onClick='alert("Ouch! That hurt.")'> <P>
 <input type=text name=url size=40 value="http://">
 <input type=button value="open"
    onClick='window.open(url.value)'> <P>
 <input type=text name=url2 size=40 value="http://">
 <input type=button value="load"
    onClick='window.location=url2.value'> <P>
 <input type=button value="color it "
    onClick='document.bgColor=color.value'>
 <input type=text name=color placeholder='type a color'>
 <input type=button value='make it white'
    onClick='document.bgColor="white"'>
</form>
```

- in a tag

```
<body onLoad='alert("Welcome to my page")'>
```

- on an image

```
<img src="smiley.jpg" onMouseover='src="frowny.gif"'
                      onMouseout='src="smiley.jpg"'>
```

- etc.

Dynamic CSS

- style properties can be set dynamically
  - color, alignment, border, margins, padding, ...
  - for individual elements, or all elements of a type, or of a given name
  - can be queried and set by Javascript

```
<script>
  window.onload = function() {
     var p = document.getElementsByTagName("P");
     for (var i = 0; i < p.length; i++) {
        p[i].onmouseover = function() {
           this.style.backgroundColor = "#deadbe";
        };
        p[i].onmouseout = function() {
           this.style.backgroundColor = "white";
        };
     }
  }
</script>
```

CSS dynamic positioning

- DOM elements have "style" attributes for positioning
  - a separate component of CSS
  - provides direct control of where elements are placed on page
  - elements can overlap other elements
    - on separate layers
- basis of animation, drag & drop
- often controlled by Javascript

```
<img src="dog.jpg" id="dog" onClick='hit()'
    style="position:absolute; left:100px; top:60px" >

var dog = document.getElementById("dog")
dog.style.left = 300 * Math.random() + "px"
dog.style.top = 300 * Math.random() + "px"
```

XMLHttpRequest ("XHR")

- interactions between client and server are usually synchronous
  - there can be significant delay
  - page has to be completely redrawn
- XMLHttpRequest provides asynchronous communication with server
  - often no visible delay
  - page does not have to be completely redrawn
- first widespread use in Google Suggest, Maps, Gmail (Feb 2005)
  - "The real importance of Google's map and satellite program, however, is not its impressive exterior but the novel technology, known as Ajax, that lies beneath." (James Fallows, *NY Times*, 4/17/05)
- Ajax: Asynchronous Javascript and XML

  (shorthand/marketing/buzzword term coined 2/05)
  - (X)HTML + CSS for presentation
  - DOM for changing display
  - Javascript to implement client actions
  - XML for data exchange with server (but it doesn't have to use XML)
  - "server agnostic": server can use any technology

Basic structure of Ajax code in browser

```
var req;
function geturl(s) {
   if (s.length > 1) {
      url = 'http://www.cs.princeton.edu/~bwk/phone3.cgi?' + s;
      loadXMLDoc(url);  // loads asynchronously
   }
}
function loadXMLDoc(url) {
   req = new XMLHttpRequest();
   if (req) {
      req.onreadystatechange = processReqChange;
      req.open("GET", url);
      req.send(null);
   }
}
function processReqChange() {
   if (req.readyState == 4) {     // completed request
      if (req.status == 200)      // successful
         show(req.responseText); // could be responseXML
   }
}
function show(s) {   // show whatever came back
   document.getElementById("place").innerHTML = s
}
```

XHR with nested function definition

```
function loadXMLDoc(url) {
    req = new XMLHttpRequest();
    if (req) {
        req.onreadystatechange = function() {
            window.status = req.statusText;
            if (req.readyState == 4) {  // completed request
                if (req.status == 200)   // successful
                    document.getElementById("place")
                      .innerHTML = req.responseText;
            }
        };
        req.open("GET", url);
        req.send(null);
    }
}
```

Callbacks

- callback: a function that is passed as an argument to another function, and executed sometime later
  - functions can be passed around like variables

    e.g., function pointers in C; like ordinary variables in most languages

- extensively used in Javascript because we don't want the browser to block waiting for response

Server script (phone2.cgi)

```
q1=`echo $QUERY_STRING | gawk '{split($0,x,"%20"); print x[1]}' `
q2=`echo $QUERY_STRING | gawk '{split($0,x,"%20"); print x[2]}' `
/usr/bin/ldapsearch -x -h ldap.princeton.edu -u -b \
   o='Princeton University,c=US' "(cn=*$q1*)"  uid cn telephoneNumber \
            studenttelephoneNumber studentstreet street ou |
php -r '
while (!feof(STDIN)) {
   $d = (fgets(STDIN));
   if (preg_match("/^#/", $d)) continue;
   if (preg_match("/^dn:|^ufn:/", $d)) continue;
   if (preg_match("/^cn:/", $d))
      if (strlen($d) > strlen($cn)) $cn = $d;
   if (preg_match("/telephoneNumber|street/", $d))
      $out = $out . " " . trim($d);
   if (preg_match("/^ou:/", $d)) $out = $out . " " . trim($d);
   if (strlen(trim($d))==0 && strlen($cn . $out) > 0) {
      $out = trim($cn) . " " . $out;
      $out = preg_replace("/Undergraduate Class of/", "", $out);
      $out = preg_replace("/cn:|ou:|telephoneNumber:|(student)?street:/", "",
      $out = preg_replace("/@Princeton.EDU/", "", $out);
      print "$out\n";
      $out = $cn = "";
   }
}' | grep -i ".*$q2" | sed -e /Success/d
```

Simpler server script (phone3.cgi)

```
#!/bin/sh

echo "Content-Type: text/html"; echo

q1=`echo $QUERY_STRING |
      gawk '{ n=split($0, x, "%20"); print x[1]}'`
q2=`echo $QUERY_STRING |
      gawk '{ n=split($0, x, "%20"); print x[2]}'`
q3=`echo $QUERY_STRING |
      gawk '{ n=split($0, x, "%20"); print x[3]}'`

grep -i "$q1" phone.txt |
grep -i ".$q2" |
grep -i ".$q3"
```

- works on precomputed data file (caching!)

Libraries, APIs, Frameworks

- browsers are not perfectly standardized
- DOM and CSS coding is messy and complicated
- web services are ever more complex

- how do we make it easy to create applications?

- libraries of common Javascript operations
  - especially access to DOM

- packages for layout with CSS

- API's, often Javascript, to access services

- frameworks: development environments for integrated client & server programming

Javascript libraries

- Javascript functions that typically provide some combination of
  - easier access to DOM
    including covering up incompatibilites
  - convenience functions for arrays, iterators, scope, etc.
  - uniform interface to Ajax
  - visual effects like fading, flying, folding, ...
  - drag and drop
  - in-place editing
  - widget sets / components: calendar, slider, progress bar, tabs, ...
  - templates for generating HTML

- there are lots of such libraries
  - jQuery, Vue, React, Angular, ...

Promises

```
var promise = new Promise(function(resolve, reject) {
  // do something, async or not, then…

  if (/* everything turned out fine */) {
    resolve("Stuff worked!");
  } else {
    reject(Error("It broke"));
  }
});

promise.then(function(result) {
  console.log(result); // "Stuff worked!"
}, function(err) {
  console.log(err); // Error: "It broke"
});
```

Debugging Javascript

- it's hard
  - weak typing, global variables, dynamic structures, semicolons, ...
- use var declarations, check balanced quotes, braces, brackets, …
- use the debugger
- use JSLint from Doug Crockford

- in Chrome
  - "tools menu" / More tools / Javascript console
- in Firefox
  - Tools / Web developer / Web Console

- use console.log to write debugging output
  - like printf
  - much better than alert(…) for most things