CSE3026: Web Application Development JavaScript

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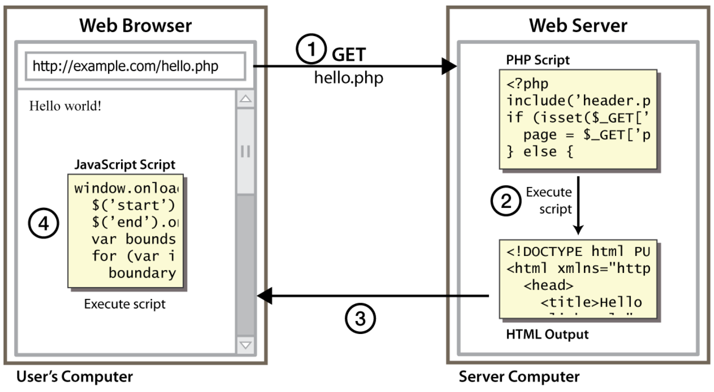
8.1: Key JavaScript Concepts

Client-side scripting



- **client-side script**: code runs in browser *after* page is sent back from server
    - often this code manipulates the page or responds to user actions

Why use client-side programming?

PHP already allows us to create dynamic web pages. Why also use client-side scripting?

- client-side scripting (JavaScript) benefits:
    - **usability**: can modify a page without having to post back to the server (faster UI)
    - **efficiency**: can make small, quick changes to page without waiting for server
    - **event-driven**: can respond to user actions like clicks and key presses
- server-side programming (PHP) benefits:
    - **security**: has access to server's private data; client can't see source code
    - **compatibility**: not subject to browser compatibility issues
    - **power**: can write files, open connections to servers, connect to databases, ...

What is JavaScript?

- a lightweight programming language ("scripting language")
- used to make web pages interactive
  - insert dynamic text into HTML (ex: user name)
  - react to events (ex: page load user click)
  - get information about a user's computer (ex: browser type)
  - perform calculations on user's computer (ex: form validation)
- a web standard (but not supported identically by all browsers)
- NOT related to Java other than by name and some syntactic similarities

JavaScript vs. Java

- **interpreted**, not compiled
- more relaxed syntax and rules
  - fewer and "looser" data types
  - variables don't need to be declared
  - errors often silent (few exceptions)
- key construct is the **function** rather than the class
  - "first-class" functions are used in many situations
- contained within a web page and integrates with its HTML/CSS content

+

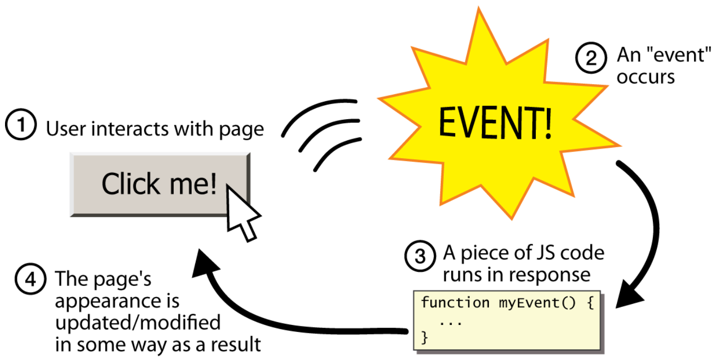
=
JavaScript

JavaScript vs. PHP

- similarities:
  - both are **interpreted**, not compiled
  - both are relaxed about syntax, rules, and types
  - both are case-sensitive
  - both have built-in regular expressions for powerful text processing
- differences:
  - JS is more object-oriented: `noun.verb()`, less procedural: `verb(noun)`
  - JS focuses on UIs and interacting with a document; PHP on HTML output and files/forms
  - JS code runs on the client's browser; PHP code runs on the web server

JS <3

Event-driven programming


1 User interacts with page
Click me!
EVENT!
2 An "event" occurs
3 A piece of JS code runs in response
function myEvent() {
...
}
4 The page's appearance is updated/modified in some way as a result

- JS programs have no `main`; they respond to user actions called **events**
- **event-driven programming**: writing programs driven by user events

Buttons: `<button>`

the canonical clickable UI control (inline)

```html
<button>Click me!</button>
```

```
Click me!
```

- button's text appears inside tag; can also contain images
- To make a responsive button or other UI control:
  1. choose the control (e.g. button) and event (e.g. mouse click) of interest
  2. write a JavaScript function to run when the event occurs
  3. attach the function to the event on the control

JavaScript functions

```
function name() {
    statement ;
    statement ;
    ...
    statement ;
}
```

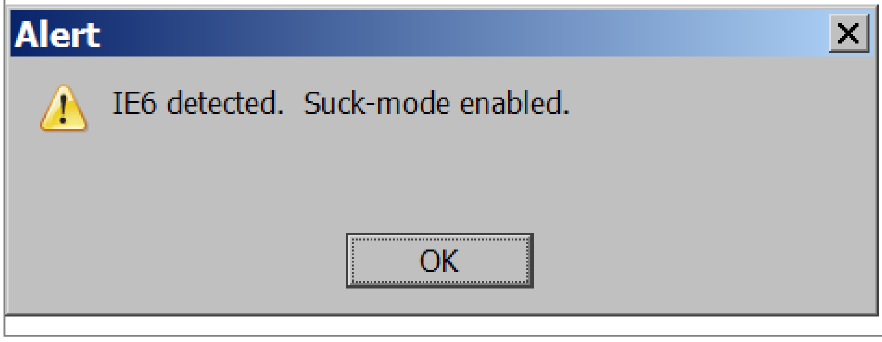
```javascript
function myFunction() {
    alert("Hello!");
    alert("How are you?");
}
```

- the above could be the contents of `example.js` linked to our HTML page
- statements placed into functions can be evaluated in response to user events

A JavaScript statement: `alert`

```
alert("message");
```

```
alert("IE6 detected.  Suck-mode enabled.");
```


Alert

IE6 detected. Suck-mode enabled.

- a JS command that pops up a dialog box with a message

Linking to a JavaScript file: `script`

```
<script src="filename" type="text/javascript"></script>
```

```
<script src="example.js" type="text/javascript"></script>
```

- `script` tag should be placed in HTML page's `head`
- script code is stored in a separate `.js` file
- JS code can be placed directly in the HTML file's `body` or `head` (like CSS)
  - but this is bad style (should separate content, presentation, and behavior)

Event handlers

```
<element attributes onclick="function();">...
```

```
<button onclick="myFunction();">Click me!</button>
```

Click me!

- JavaScript functions can be set as **event handlers**
  - when you interact with the element, the function will execute
- `onclick` is just one of many event HTML attributes we'll use

- but popping up an `alert` window is disruptive and annoying
  - A better user experience would be to have the message appear on the page...

8.2: JavaScript Syntax

Variables and types

```
var name = expression;
```

```
var age = 32;
var weight = 127.4;
var clientName = "Connie Client";
```

- variables are declared with the `var` keyword (case sensitive)
- types are not specified, but JS does have types ("loosely typed")
    - `Number`, `Boolean`, `String`, `Array`, `Object`, `Function`, `Null`, `Undefined`
    - can find out a variable's type by calling `typeof`

`Number` type

```
var enrollment = 99;
var medianGrade = 2.8;
var credits = 5 + 4 + (2 * 3);
```

- integers and real numbers are the same type (no `int` vs. `double`)
- same operators: `+ - * / % ++ -- = += -= *= /= %=`
- similar precedence to Java
- many operators auto-convert types: `"2" * 3` is `6`

`String` type

```
var s = "Connie Client";
var fName = s.substring(0, s.indexOf(" "));   // "Connie"
var len = s.length;                           // 13
var s2 = 'Melvin Merchant';                   // can use "" or ' '
```

- methods: `charAt`, `charCodeAt`, `fromCharCode`, `indexOf`, `lastIndexOf`, `replace`, `split`, `substring`, `toLowerCase`, `toUpperCase`
  - `charAt` returns a one-letter `String` (there is no `char` type)
- `length` property (not a method as in Java)
- concatenation with `+` : `1 + 1` is `2`, but `"1" + 1` is `"11"`

More about `String`

- escape sequences behave as in Java: `\' \" \& \n \t \\`
- to convert between numbers and `String`s:

```
var count = 10;
var s1 = "" + count;                          // "10"
var s2 = count + " bananas, ah ah ah!";       // "10 bananas, ah ah ah!"
var n1 = parseInt("42 is the answer");        // 42
var n2 = parseFloat("booyah");                // NaN
```

- to access characters of a `String`, use `[`*index*`]` or `charAt`:

```
var firstLetter = s[0];
var firstLetter = s.charAt(0);
var lastLetter = s.charAt(s.length - 1);
```

Comments (same as Java)

```
// single-line comment

/* multi-line comment */
```

- identical to Java's comment syntax
- recall: 4 comment syntaxes
  - HTML: `<!-- comment -->`
  - CSS/JS/PHP: `/* comment */`
  - Java/JS/PHP: `// comment`
  - PHP: `# comment`

`for` loop (same as Java)

```
for (initialization; condition; update) {
    statements;
}
```

```
var sum = 0;
for (var i = 0; i < 100; i++) {
    sum = sum + i;
}
```

```
var s1 = "hello";
var s2 = "";
for (var i = 0; i < s.length; i++) {
    s2 += s1[i] + s1[i];
}
// s2 stores "hheelllloo"
```

Math object

```
var rand1to10 = Math.floor(Math.random() * 10 + 1);
var three = Math.floor(Math.PI);
```

- methods: `abs`, `ceil`, `cos`, `floor`, `log`, `max`, `min`, `pow`, `random`, `round`, `sin`, `sqrt`, `tan`
- properties: `E`, `PI`

Logical operators

- `> < >= <= && || ! == != === !==`
- most logical operators automatically convert types:
  - `5 < "7"` is `true`
  - `42 == 42.0` is `true`
  - `"5.0" == 5` is `true`
- `===` and `!==` are strict equality tests; checks both type and value
  - `"5.0" === 5` is `false`

`if/else` statement (same as Java)

```
if (condition) {
    statements;
} else if (condition) {
    statements;
} else {
    statements;
}
```

- identical structure to Java's `if/else` statement
- JavaScript allows almost anything as a *condition*

Boolean type

```
var iLike3026 = true;
var ieIsGood = "IE6" > 0;   // false
if ("web dev is great") {  /* true */ }
if (0) {  /* false */ }
```

- any value can be used as a `Boolean`
  - "falsey" values: `0`, `0.0`, `NaN`, `""`, `null`, and `undefined`
  - "truthy" values: anything else
- converting a value into a `Boolean` explicitly:
  - `var boolValue = Boolean(otherValue);`
  - `var boolValue = !!(otherValue);`

```
“” == 0  => true
“\t” == 0 => true
“ ” == 0 => true
“ “ === 0 => false

var e = “espresso”;
var n = null;

var c = e || “latte” => “espresso”
var c2 = n || “latte” => “latte”
```

`while` loops (same as Java)

```
while (condition) {
    statements;
}
```

```
do {
    statements;
} while (condition);
```

- `break` and `continue` keywords also behave as in Java

Arrays

```
var name = [];                          // empty array
var name = [value, value, ..., value];   // pre-filled
name[index] = value;                     // store element
```

```
var ducks = ["Huey", "Dewey", "Louie"];

var stooges = [];         // stooges.length is 0
stooges[0] = "Larry";     // stooges.length is 1
stooges[1] = "Moe";       // stooges.length is 2
stooges[4] = "Curly";     // stooges.length is 5
stooges[4] = "Shemp";     // stooges.length is 5
```

- two ways to initialize an array
- `length` property (grows as needed when elements are added)

Array methods

```
var a = ["Stef", "Jason"];    // Stef, Jason
a.push("Brian");              // Stef, Jason, Brian
a.unshift("Kelly");           // Kelly, Stef, Jason, Brian
a.pop();                      // Kelly, Stef, Jason
a.shift();                    // Stef, Jason
a.sort();                     // Jason, Stef
```

- array serves as many data structures: list, queue, stack, ...
- methods: `concat`, `join`, `pop`, `push`, `reverse`, `shift`, `slice`, `sort`, `splice`, `toString`, `unshift`
  - `push` and `pop` add / remove from back
  - `unshift` and `shift` add / remove from front
  - `shift` and `pop` return the element that is removed

Splitting strings: `split` and `join`

```
var s = "the quick brown fox";
var a = s.split(" ");          // ["the", "quick", "brown", "fox"]
a.reverse();                   // ["fox", "brown", "quick", "the"]
s = a.join("!");               // "fox!brown!quick!the"
```

- `split` breaks apart a string into an array using a delimiter
  - can also be used with **regular expressions** surrounded by `/`:

    ```
    var a = s.split(/[ \t]+/);
    ```

- `join` merges an array into a single string, placing a delimiter between them

Defining functions

```
function name() {
    statement ;
    statement ;
    ...
    statement ;
}
```

```
function myFunction() {
    alert("Hello!");
    alert("How are you?");
}
```

- the above could be the contents of `example.js` linked to our HTML page
- statements placed into functions can be evaluated in response to user events

Special values: `null` and `undefined`

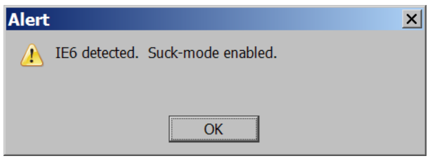
```
var ned = null;
var benson = 9;
var caroline;

// at this point in the code,
//   ned is null
//   benson's 9
//   caroline is undefined
```

- `undefined` : has not been declared, does not exist
- `null` : exists, but was specifically assigned an empty or `null` value
- Why does JavaScript have both of these?

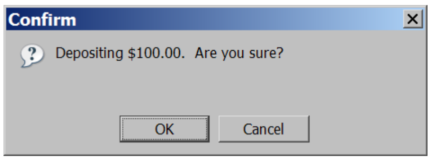
Popup boxes

```
alert("message");       // message
confirm("message");     // returns true or false
prompt("message");      // returns user input string
```


Alert

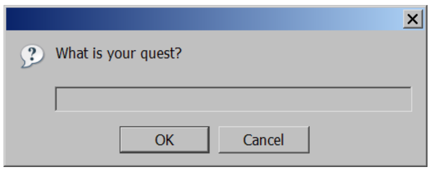
IE6 detected. Suck-mode enabled.

OK


Confirm

Depositing $100.00. Are you sure?

OK Cancel

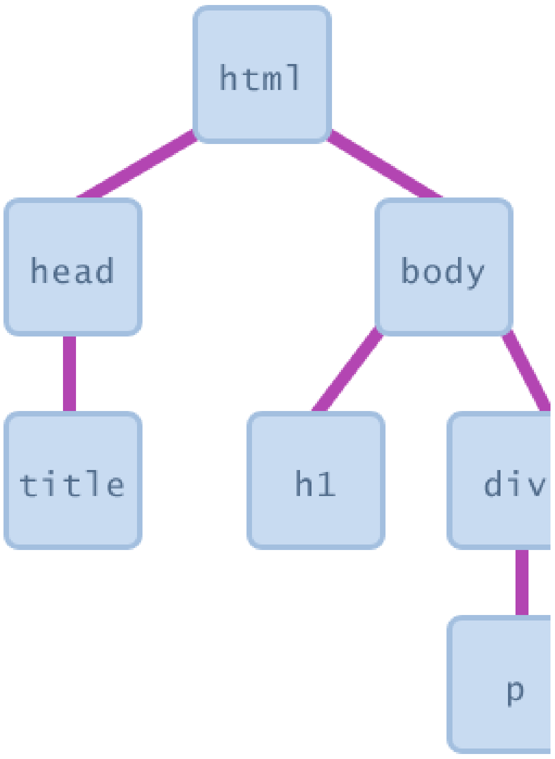

What is your quest?

OK Cancel

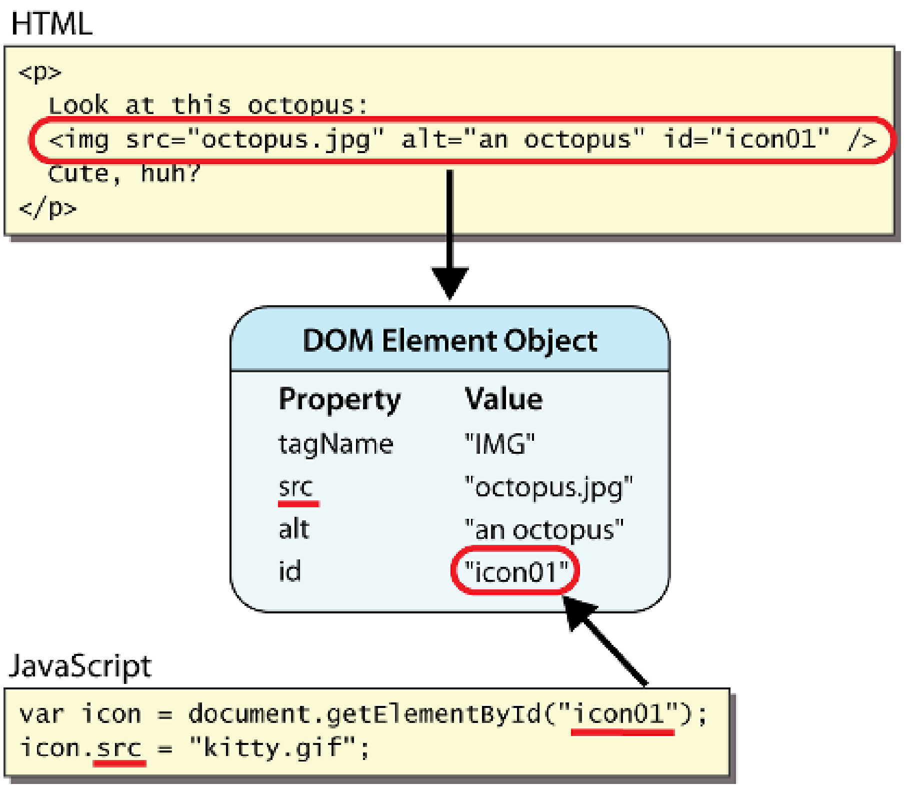
Document Object Model (DOM)

a set of JavaScript objects that represent each element on the page

- most JS code manipulates elements on an HTML page
- we can examine elements' state
  - e.g. see whether a box is checked
- we can change state
  - e.g. insert some new text into a `div`
- we can change styles
  - e.g. make a paragraph red



DOM element objects



```
<p>
  Look at this octopus:
  <img src="octopus.jpg" alt="an octopus" id="icon01" />
  Cute, huh?
</p>
```

```
var icon = document.getElementById("icon01");
icon.src = "kitty.gif";
```

- every element on the page has a corresponding DOM object
- access/modify the attributes of the DOM object with *objectName*.*attributeName*

DOM object properties

```
<div id="main" class="foo bar">
    <p>Hello, <em>very</em> happy to see you!</p>
    <img id="icon" src="images/borat.jpg" alt="Borat" />
</div>
```

```
var mainDiv = document.getElementById("main");
var icon    = document.getElementById("icon");
```

Property	Description	Example
`tagName`	element's HTML tag	`mainDiv.tagName` is `"DIV"`
`className`	CSS classes of element	`mainDiv.className` is `"foo bar"`
`innerHTML`	content in element	`mainDiv.innerHTML` is `"\n <p>Hello, <em>ve...`
`src`	URL target of an image	`icon.src` is `"images/borat.jpg"`

DOM properties for form controls

```
<input id="sid" type="text" size="7" maxlength="7" />
<input id="frosh" type="checkbox" checked="checked" /> Freshman?
```

```
var sid   = document.getElementById("sid");
var frosh = document.getElementById("frosh");
```

Property	Description	Example
`value`	the text/value chosen by the user	`sid.value` could be `"1234567"`
`checked`	whether a box is checked	`frosh.checked` is `true`
`disabled`	whether a control is disabled (boolean)	`frosh.disabled` is `false`
`readOnly`	whether a text box is read-only	`sid.readOnly` is `false`

Accessing elements: `document.getElementById`

```
var name = document.getElementById("id");
```

```
<button onclick="changeText();">Click me!</button>
<input id="output" type="text" value="replace me" />
```

```
function changeText() {
    var textbox = document.getElementById("output");
    textbox.value = "Hello, world!";
}
```

- `document.getElementById` returns the DOM object for an element with a given `id`
- can change the text in most form controls by setting the `value` property

Modifying text inside an element

```
var paragraph = document.getElementById("welcome");
paragraph.innerHTML = "Welcome to our site!";  // change text on page
```

DOM element objects have the following properties:

- `innerHTML` : text and/or HTML tags inside a node
- `textContent` : text (no HTML tags) inside a node
    - simpler than `innerHTML`, but not supported in IE6
- `value` : the value inside a form control

More advanced example

```
<button onclick="swapText();">Click me!</button>
<span id="output2">Hello</span>
<input id="textbox2" type="text" value="Goodbye" />
```

```
function swapText() {
    var span = document.getElementById("output2");
    var textBox = document.getElementById("textbox2");
    var temp = span.innerHTML;
    span.innerHTML = textBox.value;
    textBox.value = temp;
}
```

- can change the text inside most elements by setting the `innerHTML` property

Abuse of `innerHTML`

```
// bad style!
var paragraph = document.getElementById("welcome");
paragraph.innerHTML = "<p>text and <a href="page.html">link</a>";
```

- `innerHTML` can inject arbitrary HTML content into the page
- however, this is prone to bugs and errors and is considered poor style
- we forbid using `innerHTML` to inject HTML tags; inject plain text only
  - (later, we'll see a better way to inject content with HTML tags in it)

Adjusting styles with the DOM

```
<button id="clickme">Color Me</button>
```

```
window.onload = function() {
    document.getElementById("clickme").onclick = changeColor;
};
function changeColor() {
    var clickMe = document.getElementById("clickme");
    clickMe.style.color = "red";
}
```

Color Me

Property	Description
`style`	lets you set any CSS style property for an element

- contains same properties as in CSS, but with `camelCasedNames`
  - examples: `backgroundColor`, `borderLeftWidth`, `fontFamily`

Common DOM styling errors

- many students forget to write `.style` when setting styles

```
var clickMe = document.getElementById("clickme");
~~clickMe.color = "red";~~
clickMe.style.color = "red";
```

- style properties are capitalized `likeThis`, not `like-this`

```
~~clickMe.style.font-size = "14pt";~~
clickMe.style.fontSize = "14pt";
```

- style properties must be set as strings, often with units at the end

```
~~clickMe.style.width = 200;~~
clickMe.style.width = "200px";
clickMe.style.padding = "0.5em";
```

  - write exactly the value you would have written in the CSS, but in quotes

JavaScript in HTML `body` (example)

```
<script type="text/javascript">
    JavaScript code
</script>
```

- JS code can be embedded within your HTML page's `head` or `body`
- runs as the page is loading
- this is considered *bad style* and shouldn't be done in this course
  - mixes HTML content and JS scripts (bad)
  - can cause your page not to validate

Injecting Dynamic Text: `document.write`

```
document.write("message");
```

- prints specified text into the HTML page
- this is very bad style; this is how newbs program JavaScript:
  - putting JS code in the HTML file's `body`
  - having that code use `document.write`
  - (this is awful style and a poor substitute for server-side PHP programming, which we'll learn later)

The `typeof` function

```
typeof(value)
```

- given these declarations:
  - `function foo() { alert("Hello"); }`
  - `var a = ["Huey", "Dewey", "Louie"];`
- The following statements are `true`:
  - `typeof(3.14) === "number"`
  - `typeof("hello") === "string"`
  - `typeof(true) === "boolean"`
  - `typeof(foo) === "function"`
  - `typeof(a) === "object"`
  - `typeof(null) === "object"`
  - `typeof(undefined) === "undefined"`

The `arguments` array

```
function example() {
    for (var i = 0; i < arguments.length; i++) {
        alert(arguments[i]);
    }
}
```

```
example("how", "are", "you");    // alerts 3 times
```

- every function contains an array named `arguments` representing the parameters passed
- can loop over them, print/alert them, etc.
- allows you to write functions that accept varying numbers of parameters

The "for each" loop

```
for (var name in arrayOrObject) {
    do something with arrayOrObject[name];
}
```

- loops over every index of the array, or every property name of the object
- using this is actually discouraged, for reasons we'll see later

Arrays as maps

```
var map = [];
map[42] = "the answer";
map[3.14] = "pi";
map["champ"] = "suns";
```

- the indexes of a JS array need not be integers!
- this allows you to store *mappings* between an index of any type ("keys") and value
- similar to Java's `Map` collection or a hash table data structure

Date object

```
var today = new Date();               // today

var midterm = new Date(2007, 4, 4);   // May 4, 2007
```

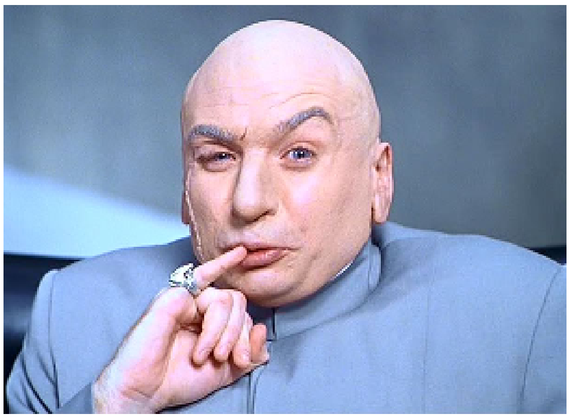
- methods
  - `getDate`, `getDay`, `getMonth`, `getFullYear`, `getHours`, `getMinutes`, `getSeconds`, `getMilliseconds`, `getTime`, `getTimezoneOffset`, `parse`, `setDate`, `setMonth`, `setFullYear`, `setHours`, `setMinutes`, `setSeconds`, `setMilliseconds`, `setTime`, `toString`
- quirks
  - `getYear` returns a 2-digit year; use `getFullYear` instead
  - `getDay` returns day of week from 0 (Sun) through 6 (Sat)
  - `getDate` returns day of month from 1 to (# of days in month)
  - `Date` stores month from 0-11 (not from 1-12)

The `eval` (evil?) function 특별한 경우가 아니면 안쓰는 것이 좋다

```
eval("JavaScript code");
```

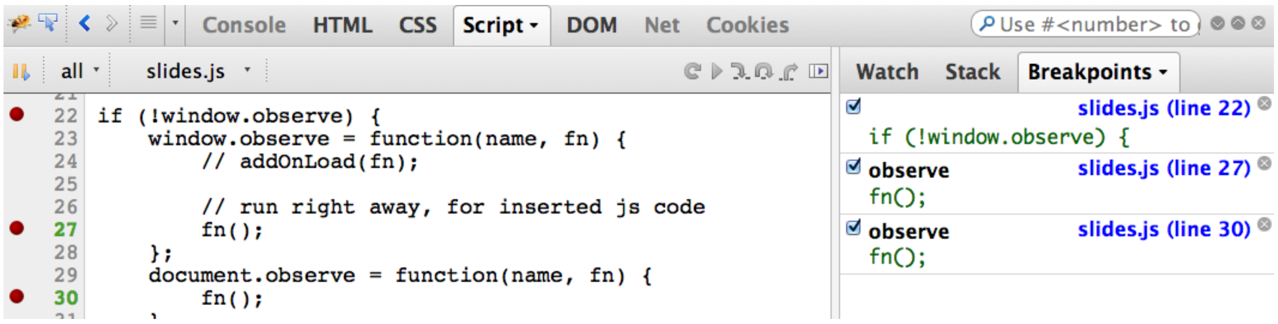
```
eval("var x = 7; x++; alert(x / 2);");  // alerts 4
```

- `eval` treats a String as JavaScript code and runs that code
- this is occasionally useful, but usually a very *bad idea*
  - if the string's contents come from user input, the user can cause arbitrary code execution
  - can lead to security problems and bugs



Debugging JS code

- Firebug/Chrome JS debugger can set breakpoints, step through code, examine values (Script tab)
- interactive console for typing in arbitrary JS expressions (Console tab)



```
22 if (!window.observe) {
23     window.observe = function(name, fn) {
24         // addOnLoad(fn);
25 
26         // run right away, for inserted js code
27         fn();
28     };
29     document.observe = function(name, fn) {
30         fn();
```

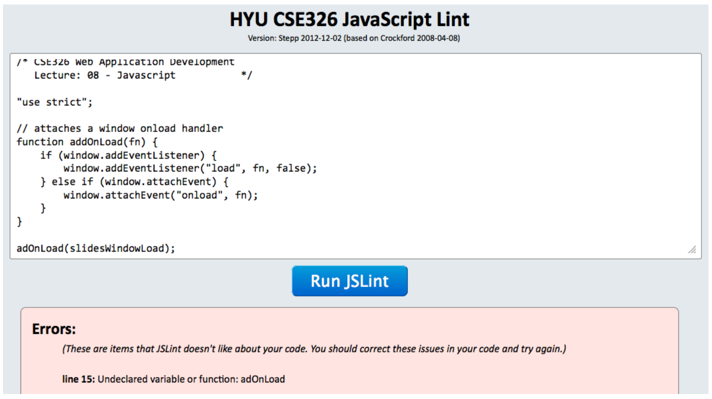
slides.js (line 22)
if (!window.observe) {

observe slides.js (line 27)
fn();

observe slides.js (line 30)
fn();

JSLint

- **JSLint**: an analyzer that checks your JS code, much like a compiler, and points out common errors
    - CSE3026 version (recommended)
    - original version, by Douglas Crockford of Yahoo!
- when your JS code doesn't work, paste it into JSLint first to find many common problems



HYU CSE326 JavaScript Lint

Version: Stepp 2012-12-02 (based on Crockford 2008-04-08)

```
/* CSE326 Web Application Development
   Lecture: 08 - Javascript          */

"use strict";

// attaches a window onload handler
function addOnLoad(fn) {
    if (window.addEventListener) {
        window.addEventListener("load", fn, false);
    } else if (window.attachEvent) {
        window.attachEvent("onload", fn);
    }
}

adOnLoad(slidesWindowLoad);
```

Errors:

(These are items that JSLint doesn't like about your code. You should correct these issues in your code and try again.)

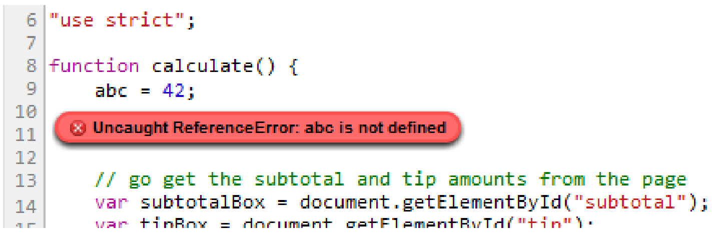
line 15: Undeclared variable or function: adOnLoad

JavaScript "strict" mode

```
"use strict";

your code...
```

- writing `"use strict";` at the very top of your JS file turns on strict syntax checking:
    - shows an error if you try to assign to an undeclared variable
    - stops you from overwriting key JS system libraries
    - forbids some unsafe or error-prone language features
- You should *always* turn on strict mode for your code in this class!



```
"use strict";

function calculate() {
    abc = 42;
Uncaught ReferenceError: abc is not defined

    // go get the subtotal and tip amounts from the page
    var subtotalBox = document.getElementById("subtotal");
    var tipBox = document.getElementById("tip");
```