

User Interface Programming

IERG4210 Lecture 3

Dr. Adonis Fung
Information Engineering, CUHK
Paranoids, Yahoo!

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Recall

- Client-side Languages for User Interface (UI) Design
 - Structure and Content - **HTML**
 - Presentation - **Cascading Style Sheet (CSS)**
 - Behavior - **JavaScript (JS)**
- Covered HTML and CSS in last lecture; JavaScript today!
- Recent advances in JavaScript shifts the paradigm of web programming. Rich web applications are nowadays heavy in client-side code

Agenda

- The **JavaScript language** itself
 - Basics, Variables
 - Functions, Object-oriented Programming
 - Arrays, Objects
 - Looping over Arrays and Objects with for and while
 - String Concatenation with Array
- **Data Object Model (DOM)**
- **Events**

JavaScript Basics (1/2)

- Governs the page behavior, to make it interactive
- Inclusion Methods into HTML (Similar to that of CSS):

- External JS file:

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

HTML

- Embedded JS code ([Why AVOID?](#)):

```
<script type="text/javascript">  
//do something here in JavaScript  
</script>
```

HTML

- Inline JS for an onclick event ([Why AVOID?](#)):

```
<input type="button" onclick="alert('Hello!')" value="Click Me!" />
```

HTML

- `<script>` tags block rendering of subsequent content

Therefore, as opposed to CSS, put them inside `<body>` instead of `<head>` whenever possible

JavaScript Basics (2/2)

- An **Object-oriented** Scripting Language
 - **Dynamic Typing** - Variable types (number/string/boolean/null/undefined) are generally dynamic. (versus statically-typed, pros and cons?)
 - **Interpreted Language** - Just-In-Time (JIT) Compilation at browsers
 - **Syntax** - Similar to C, Java
- You're expected to master in C/C++/Java taught in CSCI Introduction to Computing :)

Variables (1/2)

- **Dynamic Typing** - The type changes with its assigned value

```
var foo = 1;      // (typeof foo) becomes 'number'  
foo = "hello";   // (typeof foo) becomes 'string'
```

JAVASCRIPT

- JavaScript uses **Function Scoping** (C uses block-level scoping)
 - Declaring in a function with `var` becomes local to that function
 - Declaring without `var` becomes global variable, i.e. under `window`

```
var foo = 1;      // global variable - under window  
window.foo = 1;  // equiv. to the above  
window['foo'] = 1; // equiv. to the above  
function a() {  
    bar = 2; foo = 2; // global variables  
    var yo = 1;      // local variable to function a()  
}
```

JAVASCRIPT

Variables (2/2)

- More examples on **Function Scoping** (good for test/exam):

JAVASCRIPT

```
var foo = 1;
function a(){
  var bar = 2, foo = 2;
  foo2 = 3;
  return foo;
}
```

```
a() == 2;           //true
foo == 1;          //true
foo2 == 3;         //true
foo2 === '3'      //false - type checking failed
typeof bar == 'undefined' //true
```

- === will check if the LHS and RHS are of the same type and value (or address for arrays and objects)

Functions

- **Function Declaration Approaches:**

```
function add(param1, param2) { return param1 + param2; }
```

JAVASCRIPT

```
var add = function(param1, param2) { return param1 + param2; }
```

JAVASCRIPT

```
function mat() { window.add = function(p1, p2) {return p1 + p2;} }
```

JAVASCRIPT

According to function scoping, the first two approaches can become **local**, while the last one is declaring a **global** function.

- **Anonymous Function** are useful for event listeners:

```
function(param1) { /* do something here */ }
```

JAVASCRIPT

To be discussed in [slide 32](#).

Basic Object-Oriented JavaScript

- JavaScript has no such a syntax like `class`. It's also `function`. :)

```
var Person = function(name, sex){  
    this.name = name || 'Unnamed';  
    this.gender = (sex && sex == 'F') ? 'F' : 'M';  
};  
Person.prototype.setName = function(name) {return this.name = name};  
Person.prototype.getName = function() {return this.name};  
Person.prototype.getGender = function() {return this.gender};
```

JAVASCRIPT

- To initialize a new instance and call the methods:

```
var p1 = new Person('Peter', 'M'),  
    p2 = new Person('Niki', 'F'),  
    p3 = new Person();  
p1.getGender() == p3.getGender(); // true  
p3.getName() == 'Unnamed'; // true  
p3.getName = function() {alert('overridden')}; // overriding method
```

JAVASCRIPT

prototype is the interface to add methods to every instance

Variable/Function Names can collide!

- **Trivial Solution:** Make the names sufficiently long to avoid collision.
- Let's view some Ugly JS Examples from HSBC:
[https://www.ebanking.hsbc.com.hk/1/2/logon?
LANGTAG=en&COUNTRYTAG=US](https://www.ebanking.hsbc.com.hk/1/2/logon?LANGTAG=en&COUNTRYTAG=US)
- Doesn't look cool at all! :(

Namespace in JavaScript (Advanced Concept)

- **Good Solution:** Leverage Function Scoping, group them in a namespace

JAVASRIPT

```
(function(){  
    var cart = window.cart = {}; // global  
  
    var a, b, c; // private variables  
    var calcSubTotal = function() { // private function  
        // calculate subtotal  
    }  
  
    cart.checkOut = function() { // public function  
        // go to the checkout page  
    };  
  
    cart.add = function(id, quantity) {  
        // store it in cookies/localStorage first  
        calcSubTotal();  
        // display it in the shopping list  
    };  
  
})();  
  
cart.calcSubTotal(); // undefined! as it's a private function  
cart.add(); // OK!
```

Arrays

- **Dynamic-sized** - Auto extend to have more elements
- **Use as a Stack** - methods available: `push()`, `pop()`
- **Other Useful Methods** - `join()`, `split()`, `shift()`, `indexOf()`, etc...

```
var x = new Array(), //empty array
    y = [],           //empty array
    z = ['Happy', 'New', 'Year', 2012];
```

JAVASCRIPT

```
x != y           // true - although both are of empty content
z.push('!');     // z is ['Happy', 'New', 'Year', 2012, '!']
z.join(' ');    // returns "Happy New Year 2012 !"
z.indexOf('Year'); // returns 2 - i.e. zero-indexed
"JS is fun".split(' '); // returns ['JS', 'is', 'fun']
// since String is an array of character
```

Looping over an Array (1/2)

- Given:

```
var z = ['Happy', 'New', 'Year', 2012];
```

JAVASCRIPT

- for loop in the traditional way:

```
for (var i = 0; i < z.length; i++) {  
    //do something with z[i], can use break and continue as in C  
}
```

JAVASCRIPT

- If you like while better:

```
var i = 0, length = z.length;  
while(i < length) {  
    //do something with z[i], can use break and continue as in C  
    i++;  
}
```

JAVASCRIPT

Looping over an Array (2/2)

- Generally, the fastest way to for-loop over an array

```
for (var i = 0, value; value = z[i]; z++) {  
    //do something with value  
}
```

JAVASCRIPT

- New approach to loop (Modern Browser support required):

```
z.forEach(function(value, index){  
    //do something with value  
})
```

JAVASCRIPT

Check out more useful ones: [forEach](#), [map](#), [reduce](#), etc...

Objects

- **Dynamic-sized** - Auto extend to have more elements
- **Key-Value Pairs** - Referenced with the key, like a hash table

```
var x = new Object(), //empty object
    y = {},           //empty object
    z = {"name":"Niki",
        "today":function(){return new Date().toLocaleDateString();}};
```

JAVASCRIPT

```
x != y;           // true - although both are of empty content
z.age = 6;        // {"name":"Niki","today":func..., "age":6}
z.age == z['age']; // true - can reference like array
z.today();       // returns "Fri Jan 27 2012" for example
```

Looping over an Object

- Traditional Approach

```
for (var key in z) {  
    // z[key] gives the value, can use break and continue as in C  
}
```

JAVASCRIPT

- Array-style Approach

```
Object.keys(z).every(function(key){  
    // z[key] gives the value  
    // return false means break; return true means continue;  
})
```

JAVASCRIPT

Reference: https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/Array/Every

String Concatenation

- **String Concatenation** - operator overloaded, means addition and concatenation

```
var w = 'Hello', x = 'World!', y = 1, z = 2012;  
w+' '+x == 'Hello World!'           // all return true  
w+x+y+z == 'HelloWorld!12012'  
y+z+w+x == '2013HelloWorld!'  
w+x+(y+z) == 'HelloWorld!2013'
```

JAVASCRIPT

em... may be it's something good for midterm/exam :)

- **Joining an Array is Faster** - very often you will concat string

```
for (var i = 0, data = []; i < 5; i++)           // fast  
    data.push(i);  
data.join(' ') == '0 1 2 3 4';                 // true
```

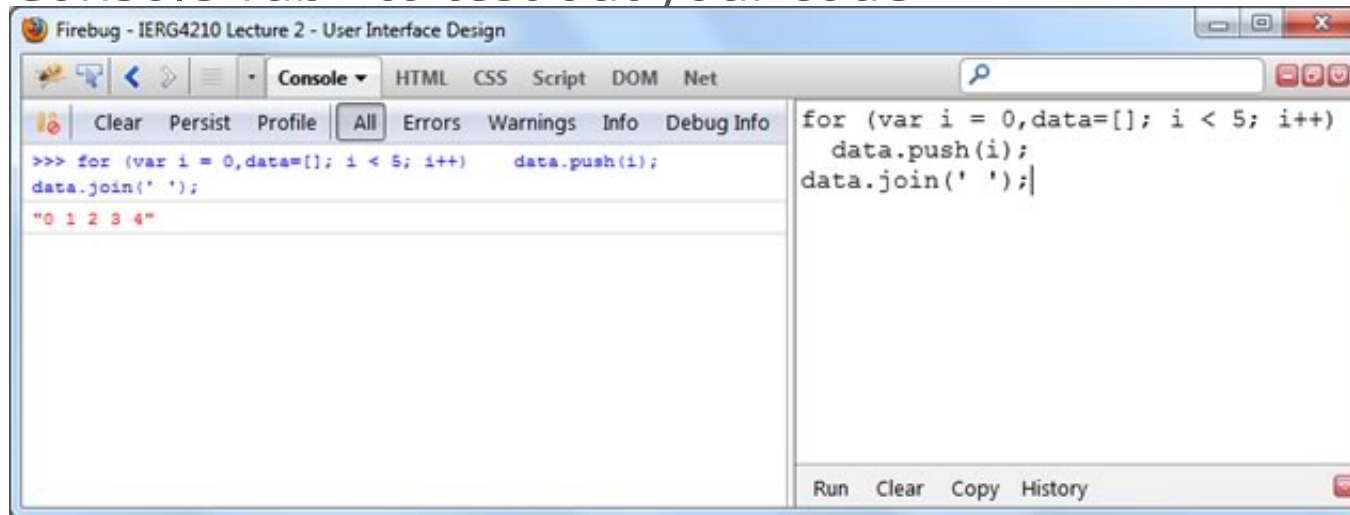
JAVASCRIPT

```
for (var i = 0, data = ''; i < 5; i++)          // slow  
    data += i + ' ';  
data == '0 1 2 3 4 ';                          // true, note the last space
```

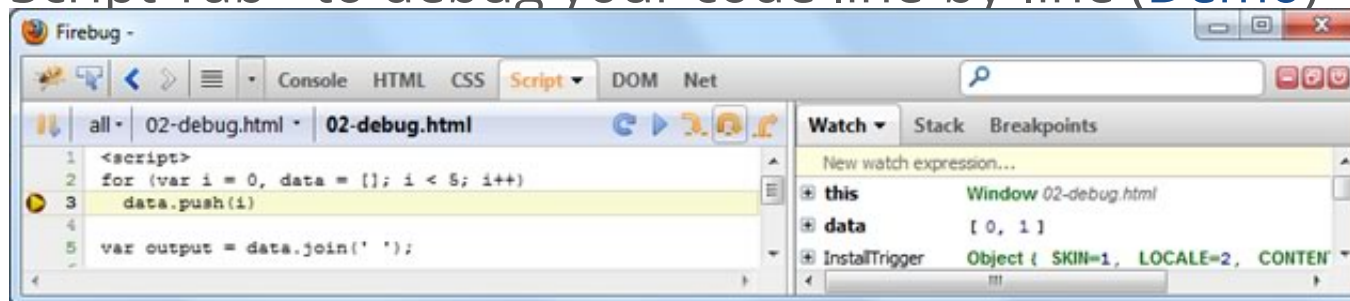
JAVASCRIPT

JavaScript Debugging in Firebug

- Console Tab - to test out your code



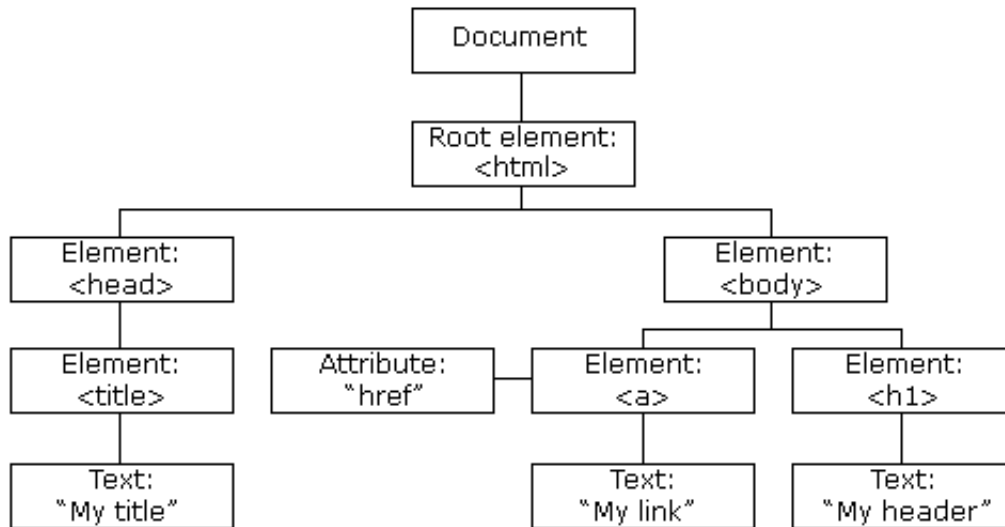
- Script Tab - to debug your code line-by-line (Demo)



JavaScript w/Data Object Model (DOM)

DOM Basics

- Every `<tag>` corresponds to a **Node Object**, therefore having its own methods and properties. The enclosure of tags forms a hierachieal tree
- For instance, LHS is translated into RHS



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

HTML

Referencing Elements (1/3)

- **Traditional Approach** - `getElementById()` and `getElementsByTagName()`

```
<ul id="header">
  <li>Hello</li>
  <li>World</li>
</ul>
```

HTML

```
<script type="text/javascript">
var ul = document.getElementById('header');
var li = ul.getElementsByTagName('li');
li[0].style.color = '#F00';
li[1].style.color = '#0F0';
</script>
```

- Hello
- World

Referencing Elements (2/3)

- **Modern Approach** - Use the CSS selectors with `querySelector()` and `querySelectorAll()`

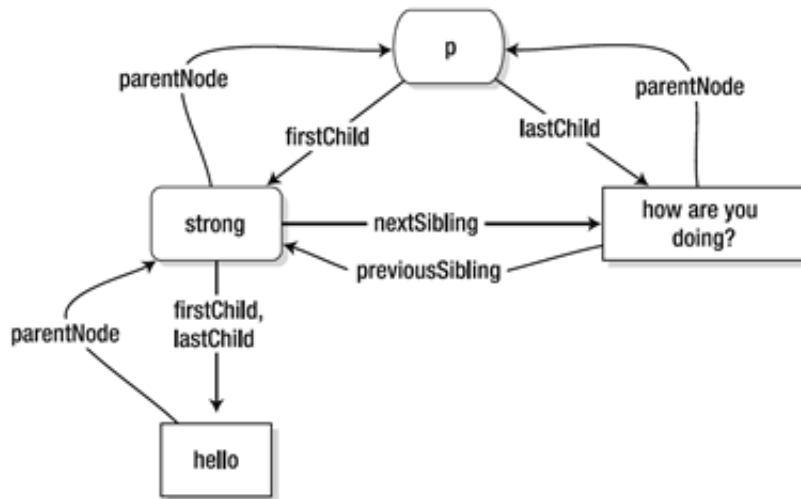
```
<ul id="header">
  <li>Hello</li>
  <li>World</li>
</ul>
```

```
<script type="text/javascript">
var li = document.querySelectorAll('#header li');
li[0].style.color = '#F00';
li[1].style.color = '#0F0';
//re-color the second <li> to #00F
document.querySelector(
  '#header li:last-child').style.color = '#00F';
</script>
```

- Hello
- World

Referencing Elements (3/3)

- **DOM Navigation** (seldom used nowadays)
 - `.parentNode`, `.childNodes`, `.nextSibling` etc...



```
<p><strong>hello</strong>how are you doing?</p>
```

```
<script type="text/javascript">  
var p = document.querySelector('p'),  
    strongs = document.getElementsByTagName('strong');
```

```
strongs[0].parentNode == p    // true
```

```
p.childNodes[0] == strongs[0] // true
```

```
</script>
```

Referencing Special Elements

- Some popular shorthands:
 - `document.head` for `<head>`
 - `document.body` for `<body>`
- Referencing forms:
 - `document.forms[n]` for the n-th child `<form>`
- Referencing links:
 - `document.links[n]` for the n-th child `<a>` and `<area>`
- Referencing frames:
 - `document.frames[n]` for the n-th child `<frame>/<iframe>`
 - Inside a frame,
 - `parent` refers to the immediate parent window
 - `top` refers to the highest parent window that its URL is reflected in the browser location bar

Common DOM Methods (1/3)

Changing Content / Adding New Elements

```
el.innerHTML = 'Your Current Time: ' + (new Date().toString());
```

JAVASCRIPT

```
// What if the string is untrusted??
```

JAVASCRIPT

```
el.innerHTML = 'something <img onerror="alert(\'DANGER\')" />'
```

- Indeed, we need something as follows to defend against XSS, to be discussed in later lectures

```
el.innerHTML = 'something <img onerror="alert(\'DANGER\')" />'  
                .replace(/</g, '&lt;');
```

JAVASCRIPT

What's the difference?

Common DOM Methods (2/3)

- Adding New Elements (DOM-based)

```
// To dynamically load a javascript file if needed  
var script = document.createElement('script');  
script.src = "dynamically-loaded.js";  
script.type = "text/javascript";  
// to add the script file as last child of document.body  
document.body.appendChild(script);  
// or, to add as the first child of document.body  
document.body.insertBefore(script, document.body.firstChild)
```

JAVASCRIPT

- So, a few lines of code (LOC) can introduce an external file that has thousand LOC.
- Can you imagine now how to extend a `` list? (Hints: use ``)

- Removing Elements (DOM-based)

```
document.body.removeChild(script);  
//to remove all children of el  
function killChildren(el){while(el.firstChild){el.removeChild(el.firstChild)}}
```

JAVASCRIPT

Common DOM Methods (3/3)

- **Changing Style Attribute (Forget this!)** - NOT recommended

```
el.style.color = '#F00';
```

JAVASCRIPT

- **Changing Class Attribute (Preferred)** - to re-style an element and its children

```
el.className = 'newClass';
```

JAVASCRIPT

```
el.classList.add('newClass')
```

JAVASCRIPT

[classList](#) is available in modern browser

- **Changing the Current Location** - apply to the current window/frame

```
window.location.replace('test2.html'); // redirect to test2.html  
window.history.go(-1); // back
```

JAVASCRIPT

Events

An element generates **events** that reflect its current status, which can be registered with event listening callback functions that respond accordingly.

```
<p>Hello, Click Me!</p>
```

```
<script type="text/javascript">  
  // assign a function to onclick handler  
  document.querySelector('p').onclick = function(e){  
    // display a simple popup dialog  
    alert('You clicked hello!');  
  }  
</script>
```

Hello, Click Me!

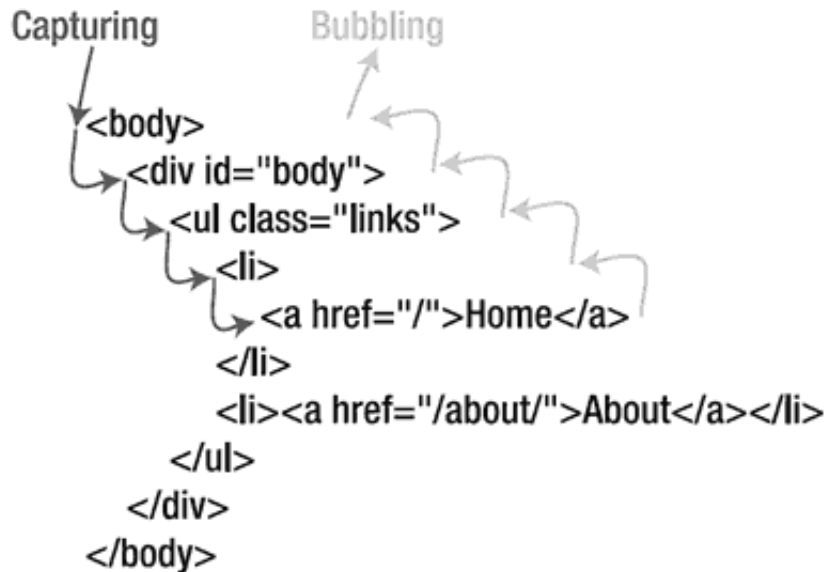
About Events

- **Asynchronous** - Events are fired out of order
- **Non-threaded** - Events get queued and fired **one at a time**
- **Some common types:**
 - **Mouse:** click, mouseover, mouseout, dragstart*, drop*
 - **Keyboard:** keydown, keypress, keyup
 - **Touchscreen:** touchstart*, touchmove*, touchend*
 - **Form/Input/Select:** submit, change, focus, blur
 - **Un/Loading:** load, beforeunload, error,readystatechange
 - **Timer:** `setTimeout()`, `setInterval()`
 - * denotes HTML5 new events

Event Phases (W3C Model)

Event propagates over the hierarchical chain of an element, going through the capturing, target, and bubbling phases.

- For instance, the target element `Home` is clicked below:



- Event listeners with **capturing order**: `<body>`, `<div>`, ``, ``, `<a>`
- Event listeners with **bubbling order**: `<a>`, ``, ``, `<div>`, `<body>`

Note: Events in IE 8 or lower only bubbles, and CANNOT be captured

Image Source: J. Resig, "Pro JavaScript Techniques", p.114, 2007

Event Listeners

- **Traditional Approach** (Cross-browser support, Bubbling)

```
el.onclick = function(e) {  
    e = e || window.event; // IE passes the event in the global window  
    alert(e.target); // e.target is a reference to the target element  
}
```

JAVASCRIPT

Will multiple event listeners in IE get mixed up with the single event object? Why?

No. Because event is non-threaded in nature as said in [slide 29](#)

- **W3C Standard** (Supported in Firefox, WebKit, IE 9, etc)

```
el.addEventListener("click", function(e) {  
    alert(e.target);  
}, false); // false for bubbling, true for capturing
```

JAVASCRIPT

IE 8 or below provides `attachEvent()` (I don't use it personally)

Event Listeners - Traditional v.s. W3C?

- Traditional is supported universally, yet risks from being overridden:

```
el.onclick = function(e) { /* given that you did something with el */ };  
// BAD colleague can append the following code:  
el.onclick = function(e) { /* do his things here, which will remove yours */ };
```

- Unless, everyone is well-behaved:

```
(function(){ // Closure, detailed in 02-reading 00 JS, p.2  
7-30  
    var _onclick = el.onclick; // _onclick now becomes a local variable  
    e  
    el.onclick = function(e){  
        // execute the existing handler if it exists, propagate the this and event object  
        _onclick && _onclick.call(this, e); // AND gate: test next operand if exists  
        /* do something else */  
    };  
})();
```

More in the reading - J. Resig, "Pro JavaScript Techniques", p.123, 2007

- W3C event handlers supports event capturing and cannot be overridden, yet it is not supported by non-standard compliant browsers like IE 32/39

Event Listeners at Bubbling Phase

```
<p id="el_p">
  <em>
    <a href="test1.html" id="el_a">Click Me!</a>
  </em>
</p>

<script type="text/javascript">
function clickMe (e){
  e = e || window.event; // for old IE
  alert('e.target.id:' + e.target.id + '\n'
    + 'this.id:' + this.id);
};

var el_p = document.getElementById('el_p'),
    el_a = document.getElementById('el_a');
el_p.onclick = clickMe;
el_a.onclick = clickMe;
// Expected Results:
// First alert: e.target.id: el_a, this.id: el_a
// Second alert: e.target.id: el_a, this.id: el_p
</script>
```

[Click Me!](#)

- `e.target` always refers to the target, while `this` refers to the one handling the event
- The event BUBBLING order: target first, and then up to the root ancestor

Event Listeners at Capturing Phase

```
<p id="el_p">
  <em>
    <a href="test1.html" id="el_a">Click Me!</a>
  </em>
</p>

<script type="text/javascript">
function clickMe (e){
  e = e || window.event; // for old IE
  alert('e.target.id:' + e.target.id + '\n'
    + 'this.id:' + this.id);
};

var el_p = document.getElementById('el_p'),
    el_a = document.getElementById('el_a');
el_p.addEventListener("click", clickMe, true);
el_a.addEventListener("click", clickMe, true);
// Results:
// First alert: e.target.id: el_a, this.id: el_p
// Second alert: e.target.id: el_a, this.id: el_a
</script>
```

[Click Me!](#)

- The event CAPTURING order: root ancestor first, and then down to target
- Hence, as opposed to last example, <p> now handles the event before <a>.

Prevent Default Action: `preventDefault()`

```
<p id="el_p">
  <em>
    <a href="test1.html" id="el_a">Click Me!</a>
  </em>
</p>
```

```
<script type="text/javascript">
function clickMe (e){
  e = e || window.event; // for old IE
  alert('e.target.id:' + e.target.id + '\n'
    + 'this.id:' + this.id);
  e.preventDefault(); // for W3C standard
  return false; // for IE 8 or below
};
```

```
var el_a = document.getElementById('el_a');
el_a.onclick = clickMe;
// Results:
// No page navigation when clicked
</script>
```

[Click Me!](#)

- The default action, page navigation to test1.html, is prevented.
- This is important to stop a form submission (i.e. stopping submit event) if it is not properly validated!!

Stop Event Propagation: `stopPropagation()`

```
<p id="el_p">
  <em>
    <a href="test1.html" id="el_a">Click Me!</a>
  </em>
</p>

<script type="text/javascript">
function clickMe (e){
  e = e || window.event; // for old IE
  alert('e.target.id:' + e.target.id + '\n'
    + 'this.id:' + this.id);
  e.stopPropagation(); // for W3C standard
  e.cancelBubble = true; // for IE 8 or below
};

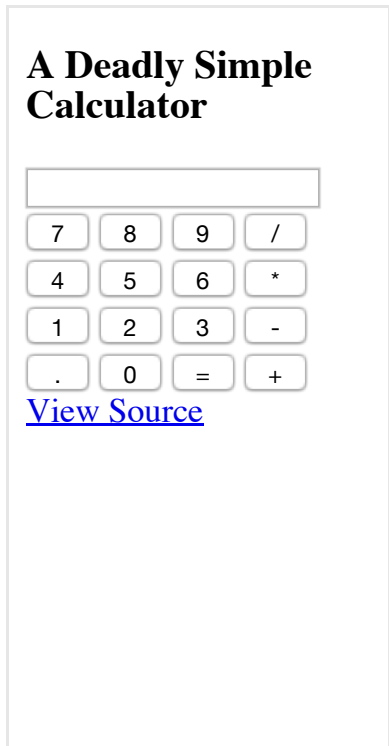
var el_p = document.getElementById('el_p'),
    el_a = document.getElementById('el_a');
el_a.onclick = clickMe; // <a> first as bubbling
el_p.onclick = clickMe;
// Result: One alert appears and displays el_a,
//          then page navigation occurs
</script>
```

[Click Me!](#)

- Event propagation is stopped at `el_a`, therefore `el_p` does not receive the event
- Note: The use of `<iframe>/<frame>` will implicitly block event from propagating
- Note: Can be workarounded not by script. Make overlapping clickable elements using CSS, thus avoiding ancestor relationship. (Demo in Facebook Timeline Profile)

JavaScript Example

- A calculator using `.getElementById()` and `.getElementsByTagName()`
- Here, 16 event listeners are registered (1 button each).
- How to reduce to only one?
 - This was one of the exam questions to assess concept of event propogations
 - Hints: [change less than 3 lines of code](#)



Advanced JavaScript Example

How to fix the problem below? **Closure** is your friend!

```
<html><body>
<script>
  for (var i = 1; i <= 3; i++) {
    var btn = document.createElement('input');
    btn.type = 'button';
    btn.value = 'button ' + i;
    // I want to alert the button number
    btn.onclick = function() {alert(i)};
    document.body.appendChild(btn);
  }
</script>
</body></html>
```

HTML



button 1 button 2 button 3

Even more advanced: [Variable Hoisting](#). Lesson learned is always put `var` on top. Use [jslint](#) to remind yourselves!

Some Logistics...

- **Deadlines:**
 - Assignment Phase 1: Jan. 26, 2015 5PM
 - Quiz 2 coming soon.
- Credit Card needed for AWS registrations
- Classroom relocation beginning next week: NAH 213