Università della Svizzera italiana

Faculty of Informatics

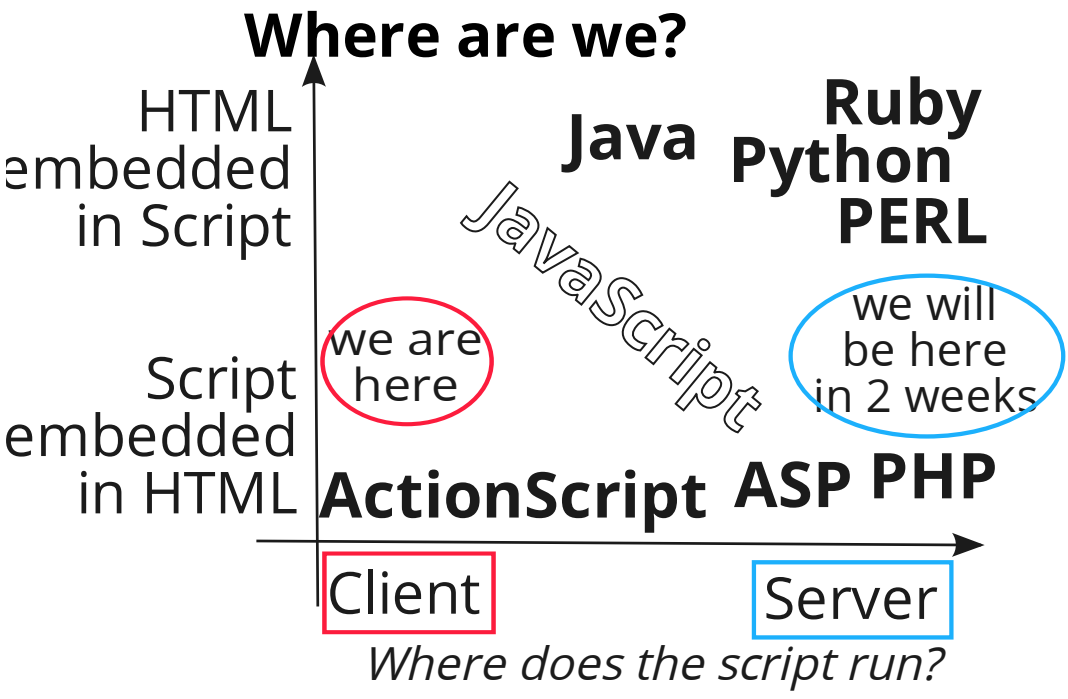
JavaScript

Prof. Cesare Pautasso

http://www.pautasso.info

cesare.pautasso@usi.ch

@pautasso



History

- Sun: Java (1994, Applets running in a Web browser)
- Netscape: Mocha/LiveScript/JavaScript (Navigator 2.0B3 - December 1995)
- Microsoft: JScript (IE3.0 August 1996)
- ECMA Standardization: ECMAScript (1.0 - 1998, 1.7 - 2006)
- JavaScript "serious" language since IE6, Firefox1

Scripting, What for?

- Add behavior to static content
- (X)HTML + CSS declarative languages for page/text layout description only
- Dynamically generate Web pages
- Modify the content of a Web page on the fly
- Run Web applications on the browser
  - Minimize latency with user interaction
  - Immediate feedback with input form validation
  - Immediate reaction to user events
  - Control the browser (history, window, popups, statusbar)

Hello World

```
<script>
  document.write("Hello World!");
</script>
```

1. When does this code run?
2. What is `document`?
3. Where do you see the output?

`document.write()` will overwrite or append to the page depending on when it is called (DO NOT USE)

When does it run?

1. Immediate Execution
   - During page load (`<body><script>`)
   - In the console
2. Event Handler
   - Respond to user actions
     - Mouse, Keyboard, Forms
     - Browser Navigation
   - Timeout events
   - Page load event
   - HTTP request events
   - Web Workers

Events

Mouse

```
onClick
onDblclick
onMousedown
onMousemove
onMouseout
onMouseover
onMouseup
```

Page

```
onLoad
onUnload
onResize
```

Touch

```
onTouchstart
onTouchmove
onTouchend
```

Input

```
onBlur
onChange
onFocus
onKeydown
onKeypress
onKeyup
onReset
onSubmit
```

Popup Message


```
<body>
  <h1 onmouseup="alert('Hello World 2')">
    Click Me
  </h1>
  <form onsubmit="alert('Hello World')">
    <input type="submit" value="Click Me"/>
  </form>
</body>
```

`alert()` blocks the browser and annoys the user (DO NOT USE)

A better Hello World

```
<script>
  document.body.innerHTML = "Hello World";
</script>
```

- Uses the `innerHTML` property instead of `document.write()`
- Runs immediately as the `<script>` tag is parsed

An even better Hello World

```
<html>
  <head>
    <script>
```

```
      function start() {
        document.body.innerHTML = "Hello World";
      }
    </script>
  </head>
  <body onload="start()">
    ...
  </body>
</html>
```

- Uses the `innerHTML` property instead of `document.write()`
- Runs after the whole page has been loaded

Functional JavaScript

Functions

```
function name(parameters) {
        var x;
        ...
        return [expression];
}
```

Function Scoping Variables defined inside a function are not visible outside of the function

`return;` = `return undefined;`

Functions - Example

```
<html>
  <head>
    <script>
      function product(a,b) {
        return a*b;
      }
    </script>
  </head>
  <body>
    <script>
      document.body.innerHTML = product(6,7);
    </script>
  </body>
</html>
```


Optional Arguments

```
function f(a,b,c) {
  if (a===undefined) { a = 1 };
  if (!b) { b = 1 };
  c = c || 1;
  return a+b*c;
}
var y = f(1,2,3);    //y = 7
var x = f(1);        //x = 2
var z = f(1,2,3,4);  //z = 7
```

Always test if parameters are defined and set them to default values if they are not (defensive programming).

Note: Use the first expression with `===` to distinguish `undefined` from `null`, `""`, `0`, `false`, since they all evaluate to `false` in the second expression.

Counting Arguments

```
function f(a,b,c) {
        var actual = arguments.length;
        var d = arguments[3];
        return a*b+c-d;
}
var expected = f.length; //3
var z = f(1,2,3,4);      //z = 1
```

You can check how many arguments a function expects (`f.length`) and how many arguments it actually gets (`arguments.length`).
Warning: out-of-bounds arrays simply return undefined.

Anonymous Functions

```
function f(x) { return 42 + x; };
var y = f(z);
```

Named Function Declaration

```
var f = function(x) { return 42 + x; };
var y = f(z);
```

Anonymous Function Expression Assigned to Variable

```
var f = function f(x) { return 42 + x; };
var y = f(z);
```

Named Function Expression Assigned to Variable

```
var y = function(x) { return 42 + x; } (z);
```

Assign Result of Anonymous Function Call

More information: Function Declarations vs. Function Expressions

Inner Functions

```
function outer(X,Y) {
  var local = 'Result: ';
  var inner = function(K) {
    var z = X + Y + K;
    alert(local + z);
    return z;
  }
  return inner(1);
}
var a = outer(-1,100);  //a = 100
```

- Basic Scope Rule: An inner function has access to the variables and parameters of all functions that it is contained within.

Functional Programming

```
function map(f, a) {
  var result = new Array;
  for (var i = 0; i != a.length; i++)
    result[i] = f(a[i]);
  return result;
}
var square = function(x) {
  return x * x;
}
var s = map(square, [0,1,2,3,4,5]);
//s = [0,1,4,9,16,25]
```

Why is this a bug?

```
var dom = [ /* DOM Elements */ ];
var N = dom.length
for (var i = 0; i < N; i++) {
  dom[i].onclick = function() {
    alert( 'You clicked on #' + i );
  };
}
```

Bug: no matter which element you click on, the alert message is always the same (You clicked on #N).
How to fix this?

Fixing the bug with a closure

```
function setupClick(num) {
   return function() {
        alert( 'You clicked on #' + num );
     };
}
function setupEventHandlers(dom) {
   for (var i = 0; i < dom.length; i++) {
      dom[i].onclick = setupClick(i);
   }
}
```

Compact Version

```
function setupEventHandlers(dom) {
  for (var i = 0; i < dom.length; i++) {
    dom[i].onclick = function(num) {
      return function() {
          alert( 'You clicked on #' + num );
        };
      } (i);
    }
  }
}
```

1. Declare the outer anonymous function with parameters, which returns the event handler anonymous function using the parameter
2. Then then call the outer anonymous function passing the actual parameter

Closures

```
function outer(X,Y) {
  var local = 'Result: ';
  var inner = function(K) {
    var z = X + Y + K;
    alert(local + z);
    return z;
  }
  return inner;
}
var f = outer(-1,100);
var a = f(1);  //a = 100
```

- Basic Scope Rule: An inner function has access to the variables and parameters of all functions that it is contained within.
- Closures: The scope that an inner function enjoys continues even after the parent functions have returned.
- A closure is a function together with its context: a snapshot of all variables accessible from it.

Closures Simple Example

```
function outer(x) {
  var inner = function(y) { return x * y; }
  return inner;
}
var one = outer(1);
//one = function(y) { return 1 * y; }
var two = outer(2);
//two = function(y) { return 2 * y; }
var a = one(10); //a = 10
var b = two(10); //b = 20
```

- Multiple closures are created every time the outer function is called. Each has its own copy of the context.

Counting with Closures

```
function outer(z) {
  var x = z || 0;
  var inner = function() { x++; return x; }
  return inner;
}
var count = outer(1);
var a = count(); //a = 2
var b = count(); //b = 3
```

- Warning: The context within a closure can be modified.

Functional Closures

```
function outer(z) {
  var x = 0;
  return function() { x = z(x); return x; };
}
var inc = outer(function(y){return y+1;});
var a = inc(); //a = 1
var b = inc(); //b = 2

var dec = outer(function(y){return y-1;});
var c = dec(); //c = -1
var d = dec(); //d = -2
```


Closures - Useful Example

```
function makeConverter(factor, offset) {
    offset = offset || 0;
    return function(input) {
        return ((offset+input)*factor).toFixed(2);
    }
}

var milesToKm = makeConverter(1.60936);
var poundsToKg = makeConverter(0.45460);
var F2C = makeConverter(0.5556, -32);

var km = milesToKm(10);   //16.09
var kg = poundsToKg(2.5); //1.14
var c = F2C(98);          //36.67
```

Adapted from: Understanding JavaScript Closures

Closures - Useful Example

```
function fadeElement(id) {
  var dom = document.getElementById(id),
      level = 1;
  function step () {
    var h = level.toString(16);
    dom.style.backgroundColor = '#FFFF' + h + h;
    if (level < 15) {
      level += 1;
      setTimeout(step, 100);
    }
    setTimeout(step, 100);
  }
}
```


Scripting the Web Browser

innerHTML

Access the HTML Parser

A much better way to produce HTML from your JavaScript without breaking the existing page structure

```
<head>
  <script>
function getTime() {
  document.getElementById('clock').innerHTML =
    '<b>' + new Date() + '</b>';
  }
  </script>
</head>
```

```
<body>
  <p>Time: <span id='clock'>?</span> </p>
  <input type='button' onclick='getTime()‘
         value='What time is it?'/>
</body>
```


eval

Access the Browser VM

```
eval(string)
```

Compile and execute a string of JavaScript code and return the result

This is what the browser does to run JavaScript code strings embedded in the HTML for running them

Warning: Can open your code to **security risks** if you do not fully trust the source of the code string

open

Control the Browser Windows

```
window.open('http://www.usi.ch', 'usi',
            'width=400,height=400');
```

```
window.close();
```

```
history.back();
```

```
history.forward();
```

Warning: The last three functions may render the current page invalid and never return!

debugger

Jump into the debugger

```
if (something is wrong) {
        debugger;
}
```

The debugger statement can be used as a programmable breakpoint

Hint: Do not use in production code

console

Log and trace your code

```
console.log("message");
```

Print a message into the console

```
console.dir(variable)
```

Structured dump of the content of a variable

```
console.time("bottleneck");
//slow code
console.timeEnd("bottleneck");
```

Profile your code bottlenecks

Tools

- Firebug (https://www.getfirebug.com/) (Firefox debugger)
- JS Lint (http://www.JSLint.com/) (Style checker)
- QUnit.js (http://qunitjs.com/) (Unit Testing)
- JS Compress (http://jscompress.com/) (Minifier)
- Greasemonkey (http://www.greasespot.net/)
- JavaScript Shell (http://www.squarefree.com/shell/shell.html)

References

- Douglas Crockford, JavaScript: The Good Parts, O'Reilly, May 2008
- Marijn Haverbeke, Eloquent JavaScript (http://eloquentjavascript.net/) : A Modern Introduction to Programming, July 2007
- Danny Goodman, Michael Morrison, JavaScript Bible, 6th Edition, Wiley, April 2007
- David Flanagan, JavaScript: The Definitive Guide, Fifth Edition, O'Reilly, August 2006
- Mark Pilgrim, Greasemonkey Hacks, O'Reilly, 2006
- Stoyan Stefanov, JavaScript Patterns: Build Better Applications with Coding and Design Patterns, O'Reilly, 2010