Javascript

Because ECMAScript sounds horrible

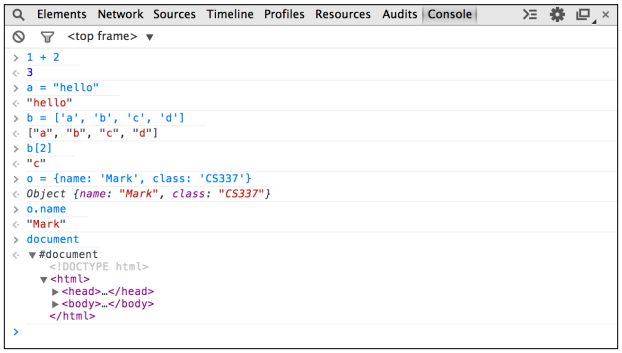
Javascript

- Javascript is a general purpose programming language.
- It usually runs within a browser
  - Node.js runs Javascript in a server / application context
- Developed in the mid nineties as a simple way to provide interactivity to web pages.
- Originally developed by Brendan Eich working at Netscape
- Submitted to ECMA standards body in 1996
- ECMAScript 5.1 released in 2011

Javascript In A Browser

- REPL
  - Read-Eval-Print Loop
- All major browsers have a Javascript REPL system in the console

Javascript In A Browser



Documentation

http://ecma262-5.com/ELS5_HTML.htm

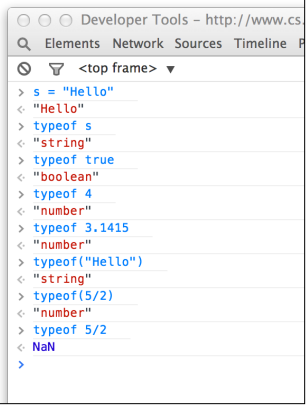
https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference

Data Types

- Basic Data Types
  - number
  - boolean
  - string
  - object

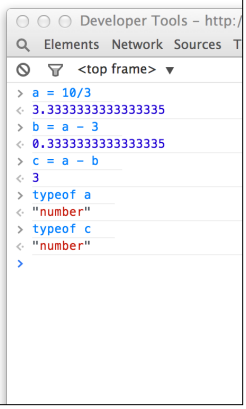
Data Types

- `typeof` unary operator
- lets us know what we're dealing with
- If you're evaluating a complex operation, you need parenthesis. Not because `typeof` is a function, but to make sure that there's only one argument to `typeof`



Numbers

- Javascript has a single number datatype to deal with all numbers.
- No distinction between integers, floats, doubles, etc.
- All numbers are represented as floating point numbers, but if the fractional part is zero, they're shown as integers.



Numbers

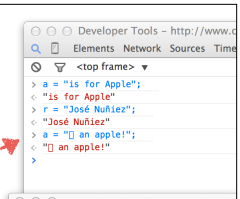
- Numbers stored in variables are converted objects when needed, to have methods and properties
- Number.toString()
- Number.toPrecision()

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

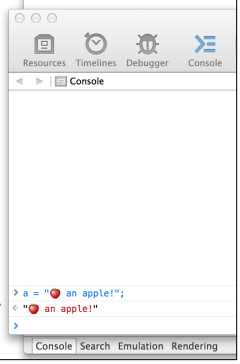
Strings

- A series of zero or more characters.
- Unicode support is pretty good.
- Browser support for full unicode support is spotty.

Chrome



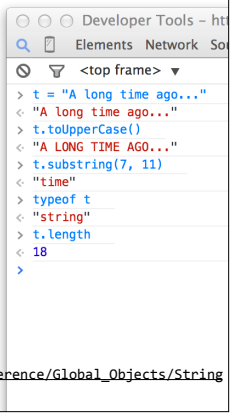
Safari



Strings

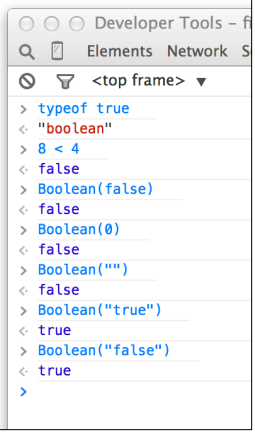
- String variables are also converted to objects as needed.
- `String.toUpperCase()`
- `String.substring(start, end)`
- Note the difference between `.substring()` and `.length`
  - One is a method, one is a property

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



Boolean

- Boolean for `true` and `false`.
- Comparisons
- Coerce other datatypes into Boolean.
- Note the behavior of the Boolean value for strings.
  - Empty string is `false`
  - Other strings are `true`. Even “false”!



Variables

- Variable names can be any combination of letters, numbers, an underscore (_), or $
- Variable names cannot start with a number.
- Variables do not need to be declared.
- The `var` keyword can be used to declare and scope variables.

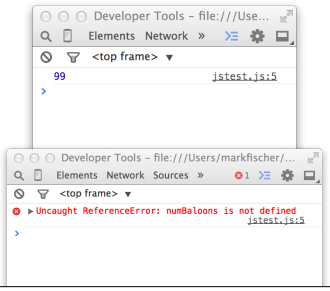
https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Statements/var

Variables

- Variables have global scope unless `var` is used to declare a variable.

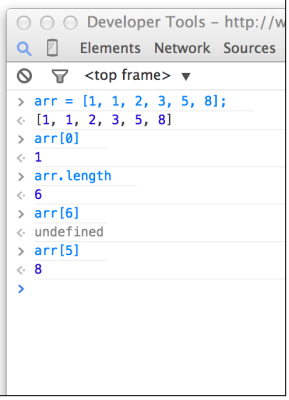
```
var foo = function() {
  numBaloons = 99;
}
foo();
console.log(numBaloons);
```

```
var foo = function() {
  var numBaloons = 99;
}
foo();
console.log(numBaloons);
```



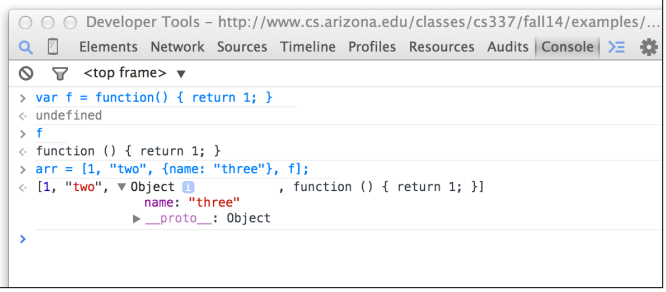
Arrays

- Collection of values
- Created with `[n, n+1,…k-1]` syntax
- Array access with brackets: `n[ ]`
- Length property
- Standard Zero based indexing



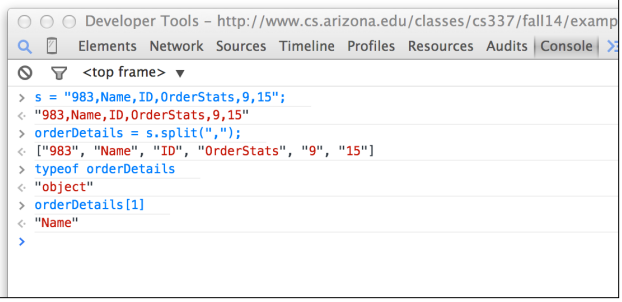
Arrays

- Arrays can be collections of many different datatypes.



Arrays From Strings

- `String.split()` to create an array from a string.



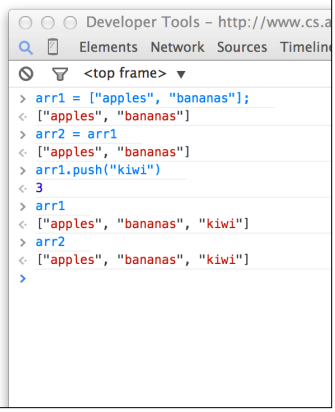
Array Methods

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

- Lots of useful array methods.
- `.contains(<some value>)` // returns true or false
- `.join(<glue string>)` // joins all elements together with glue and returns a string.
- `.toString()` // Quick string representation of the array
- `.pop()` `.push()` `.shift()` `.unshift()` // Standard array methods
- `.sort()` // Sorts elements according to criteria
- `.splice()` // Adds or removes elements from an array

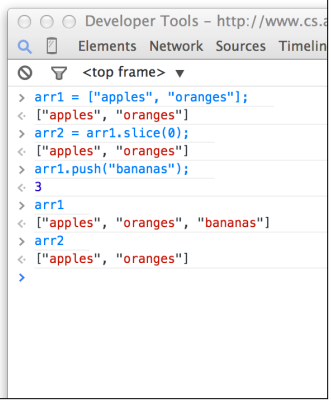
Array Assignment

- Assigning an array to another variable assigns a reference of the array to the variable, not a copy.



Array Assignment

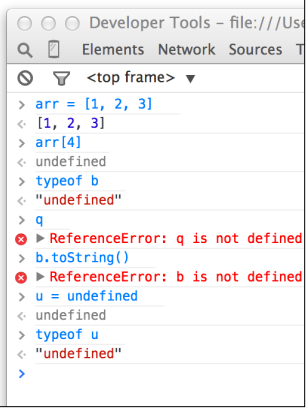
- To make a copy of an array, use the `.slice(0)` method.



undefined

developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/undefined

- Javascript has a special value for things that are not defined: **`undefined`**
- Out of bounds requests
- Un-initialized variables
- **`undefined`** is a property of the *global object*. Its type is undefined.



Objects

- Objects are very flexible data structures.
- A basic object:

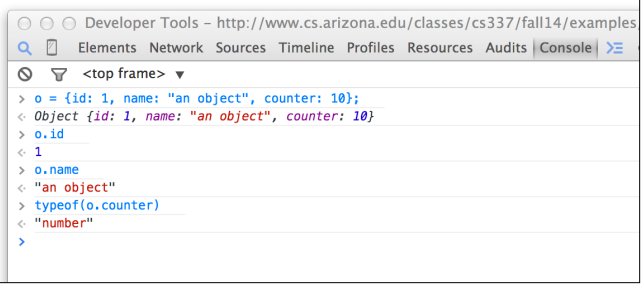
```
o = {id: 1, name: "an object", counter: 10};
```

- Create property names and values using `key: value` syntax.
- Separate multiple properties by commas.

Objects

```
o = {id: 1, name: "an object", counter: 10};
```

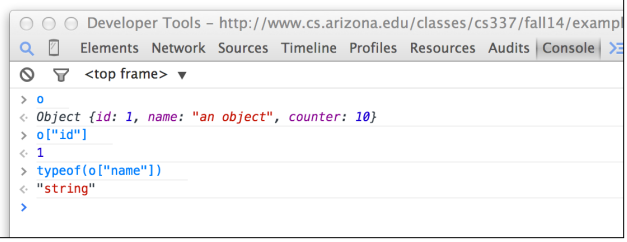
- Access properties via dot syntax



Objects

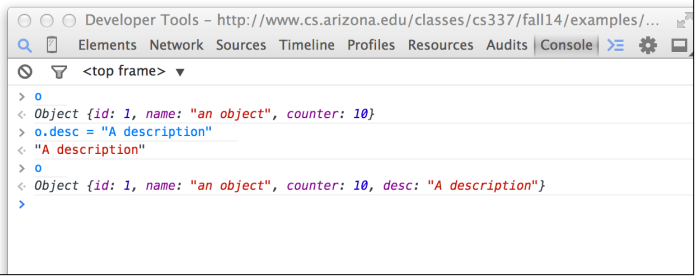
```
o = {id: 1, name: "an object", counter: 10};
```

- Act as “Associative Arrays” or “Key / Value” arrays, or “Dictionary” array
- `arr["key"]` syntax



Objects

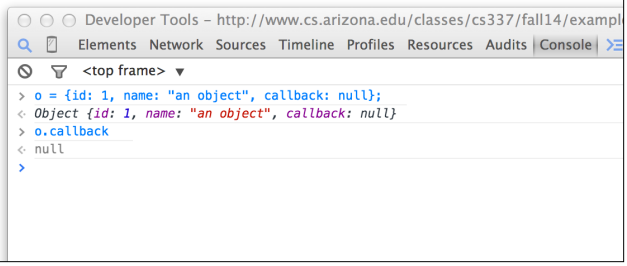
- Assigning to undefined properties creates them



null

developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/null

- Null is a literal value representing an “empty” or non-existent value.



Operators

- Arithmetic Operators: `+ - / * % ++ --`
- String concatenation: `+`
- Logical Operators: `&& || !`
- Comparisons: `< > <= >=`
- Ternary Operator: `condition ? true expr : false expr`
- Bitwise Operators: `<< >> ^ ~`

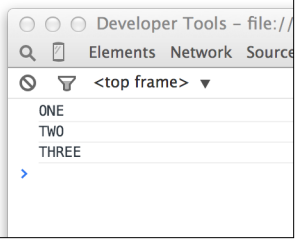
Control Structures

- `if (condition) { stmt1 } else { stmt2 }`
- `while (condition) { statements }`
- `for (i = 0; i < 10; i++) { statements }`
- Pretty much work like every other C or Java style language

Control Structures: forEach

```
a = ["one", "two", "three"];
a.forEach(function(element, index, arr) {
  console.log( element.toUpperCase() );
});
```

- Arrays have a special `forEach` method for performing some action relating to each element of the array
- The `forEach` method takes a *function* as an argument.

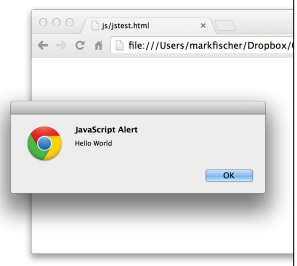


Basic I/O

- Alerts
- Log to Console
- Confirms
- Prompt
- DOM Manipulation
- Debugger
- No Direct Local File I/O!

alert( )

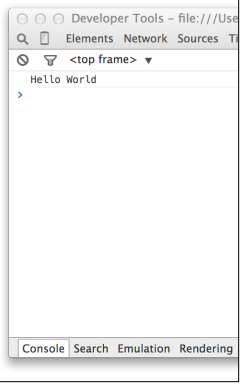
```
alert("Hello World");
```



- Display a modal dialog box with the specified text.
- Pauses execution of Javascript until dialog is dismissed.

console.log( )

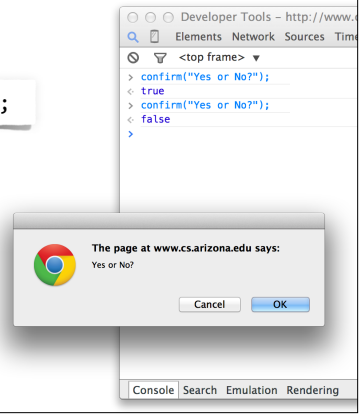
```
console.log("Hello World");
```



- Quick way to get some debugging out.
- Doesn't block execution, so usually a better choice for debugging and testing than **`alert()`**.

confirm( )

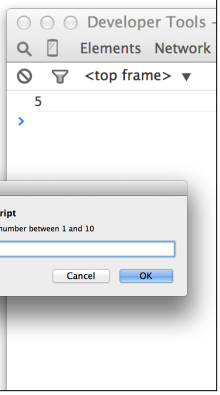
```
confirm("Yes or No?");
```



- Ask for a **`true`** or **`false`** response from the user.

prompt( )

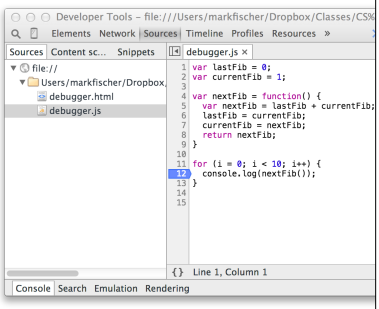
```
prompt("Enter a number between 1 and 10");
console.log(i);
```



- Ask for user input as a text string.

Debugger

- Most browsers have a full featured interactive debugger built in.
- Breakpoints, watched expressions, step through execution, etc.
- Example.



Functions

- Multiple ways to define a function

```
function echo(a) {
  return a;
}

echoTwo = function(a) {
  return a;
}

var echoThree = function(a) {
  return a;
}

console.log( echo("one") );
console.log( echoTwo("two") );
console.log( echoThree("three") );
```

Functions

Declares a named function without requiring assignment

Declares a *global* variable `echoTwo` and assigns an anonymous function to it

Declares a *local* variable `echoThree` and assigns an anonymous function to it

```
function echo(a) {
  return a;
}

echoTwo = function(a) {
  return a;
}

var echoThree = function(a) {
  return a;
}

console.log( echo("one") );
console.log( echoTwo("two") );
console.log( echoThree("three") );
```

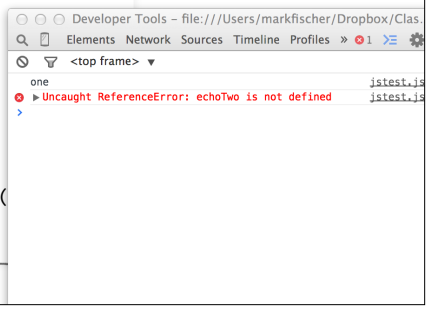
Functions

- Does any of this matter?
- What if we call the functions before they're declared?

```
console.log( echo("one") );
console.log( echoTwo("two") );
console.log( echoThree("three") );

function echo(a) {
  return a;
}

echoTwo = function(a) {
  return a;
}

var echoThree = function(a) {
  return a;
}
```

Functions

```
console.log( echo("one") );
console.log( echoTwo("two") );
console.log( echoThree("three") );

function echo(a) {
  return a;
}

echoTwo = function(a) {
  return a;
}

var echoThree = function(
  return a;
}
```

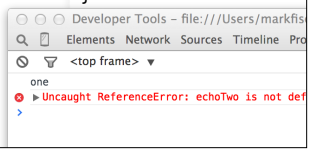


Functions

- The first style has a symbol table entry created for it at parse time. So it can be referenced immediately during runtime.
- The other two have symbol table entries created at runtime, so aren't available until after they've been executed.

javascriptweblog.wordpress.com/2010/07/06/function-declarations-vs-function-expressions/

```
console.log( echo("one
console.log( echoTwo("
console.log( echoThree

function echo(a) {
  return a;
}

echoTwo = function(a)
  return a;
}

var echoThree = functi
  return a;
}
```



Functions

```
//Function Declaration
function add(a,b) {return a + b};
//Function Expression
var add = function(a,b) {return a + b};
```

- So should we always use Function Declarations?
  - Well, it depends…

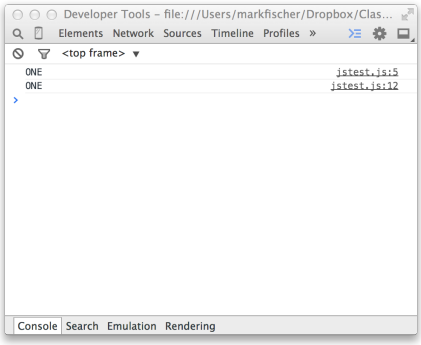
Functions

- What is the console output here?

```
function echo(a) {
  return a;
}

console.log( echo("one") );


function echo(a) {
  return a.toUpperCase();
}

console.log( echo("one") );
```

Functions

- Hmm, maybe not what we were expecting.
- Function Declarations are ‘hoisted’ to the top at parse time, so when executed, the last declared version wins.



Function Declarations

- Can only appear as block level elements.
- Are ‘hoisted’ to the top at parse time, before run time.
- Cannot be nested within non-function blocks.
- Are scoped by where they are declared, like `var`

Function Expressions

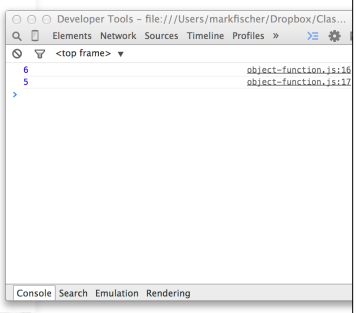
- Can be used anywhere an expression is valid.
  - Can be more flexible because of this.
- Are evaluated and assigned at run time.

Objects and Functions

- Functions can be added to objects as property variables.
- Many object “methods” are really properties with functions assigned to them.

Objects and Functions

```
var doubleMe = function doubleMe(x) {
  return 2 * x;
}

var halveMe = function halveMe(x) {
  return x/2;
}

var myLib = {
  version: 0.3,
  name: "My Test Library",
  double: doubleMe,
  half: halveMe
}

console.log( myLib.double(3) );
console.log( myLib.half(10) );
```



Objects and Functions

- Using anonymous function expressions instead.

```
var myLib = {
  version: 0.4,
  name: "My Test Library",
  double: function(x) { return 2 * x; },
  half: function(x) { return x/2; }
}

console.log( myLib.double(3) );
console.log( myLib.half(10) );
```

Javascript in HTML

- Where does our Javascript live?
- Inline in an HTML document inside a `<script>` element
- Included in an external file via a `<script>` element.

Javascript in HTML

- The `<script>` element with inline content
- Within the `<script>` element, we're parsing Javascript, not HTML

```
<!doctype html>
<head>
  <title>js/jstest.html</title>

  <script>
    var answer = 42;
    function calculateAnswer() {
      return answer;
    }
    console.log( calculateAnswer() );
  </script>
</head>

<body>
  <div></div>
  <div></div>
</body>
</html>
```

Javascript in HTML

- The `<script>` element with src attribute.
- Includes an external file with Javascript in it.
- No wrapping `<script>` tags within external files.

```
<!doctype html>
<html>
<head>
  <title>js/jstest.html</title>
  <script src="jstest.js"></script>
</head>

<body>
  <div></div>
</body>
</html>
```

```
var answer = 42;
function calculateAnswer() {
  return answer;
}
console.log( calculateAnswer() );
```

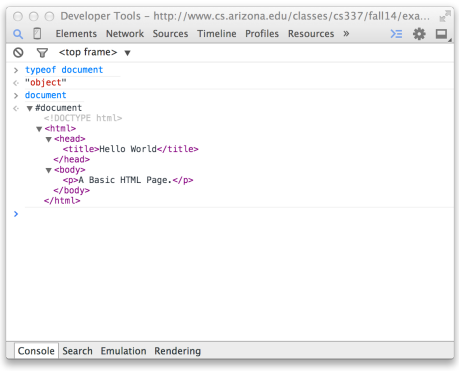
The `document` Object

This is all well and good, but how about something involving a web page?

The `document` Object

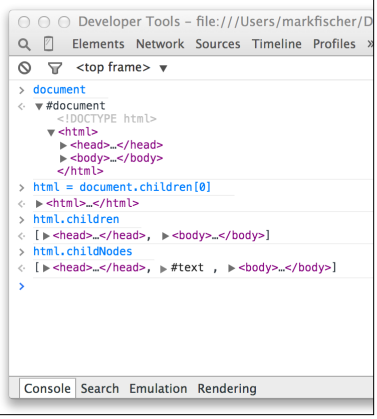
- Browsers parse the HTML and CSS of a page, and build an object model in memory.
- The browser exposes this object to us for use with our Javascript as the `document` object.

The `document` Object



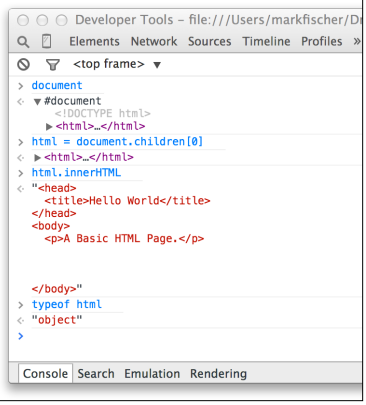
The `document` Object

- The document object represents the root element of our DOM tree.
- It has child nodes, and each node has various attributes.
- Note the difference between .children and .childNodes



The `document` Object

- **`document`** elements are *objects*, so accessing their properties is done with the dot syntax
- **`object.property`**
- **`html.innerHTML`** for example



The `document` Object

- The **`document`** object is *NOT* part of the Javascript language.
- It is an API defined by the W3C to interact with HTML and XML documents.

https://developer.mozilla.org/en-US/docs/Web/API/Document_Object_Model

DOM Selection

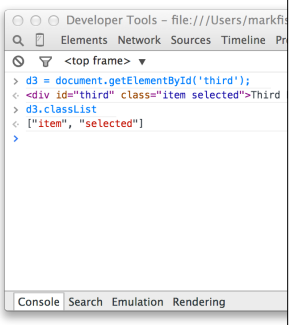
- Starting with the **`document`** root and drilling down via **`.children`** is tedious. Can we get at elements some other way?
- `document.getElementByID("main")`
- `document.getElementsByTagName("p")`
- `document.getElementsByClassName("error")`

getElementById

- Gets an HTMLElement object from the document based on an ID.
- Since ID must be unique, this method returns a single element, not an array of elements.

getElementById

```
<!doctype html>
<head>
  <title>js/getElementById.html</title>
  <link rel="stylesheet" type="text/css"
                  href="getElements.css" />
</head>

<body>
  <div id="main">
    <div id="first" class="item">
      First Block
    </div>
    <div id="second" class="item">
      Second Block
    </div>
    <div id="third" class="item selected">
      Third Block
    </div>
  </div>
</body>
</html>
```



Updating the DOM

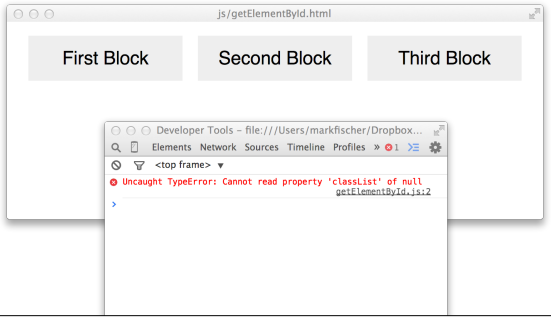
- Now that we can get an element, can we do something with it?

```
<!doctype html>
<head>
  <title>js/getElementById.html</title>
  <link rel="stylesheet" type="text/css"
                    href="getElements.css" />
  <script src="getElementById.js"></script>
</head>

<body>
  <div id="main">
    <div id="first" class="item">First Block</div>
    <div id="second" class="item">Second Block</div>
    <div id="third" class="item">Third Block</div>
  </div>
</body>
</html>
```

```
d2 = document.getElementById('second');
d2.classList.add("selected");
```

Updating the DOM

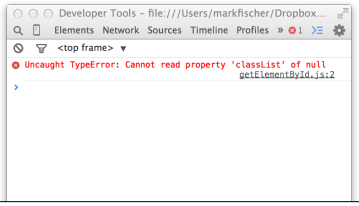
- Hmm nothing happened. Why? Check the console.



Updating the DOM

- Uncaught TypeError: Cannot read property 'classList' of null?? But how can d2 be null?

```
d2 = document.getElementById('second');
d2.classList.add("selected");
```




```
<!doctype html>
<head>
  <title>js/getElementById.html</title>
  <link rel="stylesheet" type="text/css"
                    href="getElements.css"
  <script src="getElementById.js"></script>
</head>

<body>
  <div id="main">
    <div id="first" class="item">First Bloc
    <div id="second" class="item">Second Bl
    <div id="third" class="item">Third Bloc
  </div>
</body>
</html>
```

Waiting for the DOM to load

- The browser waits for no DOM
- The browser parses the file, loads the **`getElementById.js`** file, and executes it all before the rest of the HTML is parsed and the DOM is created.

```
<!doctype html>
<head>
  <title>js/getElementById.html</title>
  <link rel="stylesheet" type="text/css"
                    href="getElements.css" />
  <script src="getElementById.js"></script>
</head>

<body>
  <div id="main">
    <div id="first" class="item">First Block</div>
    <div id="second" class="item">Second Block</div>
    <div id="third" class="item">Third Block</div>
  </div>
</body>
</html>
```

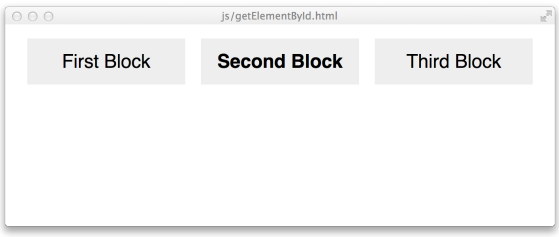
Waiting for the DOM to load

- What if we just move the **`<script>`** element down to the bottom?

```
<!doctype html>
<head>
  <title>js/getElementById.html</title>
  <link rel="stylesheet" type="text/css"
                    href="getElements.css" />
</head>

<body>
  <div id="main">
    <div id="first" class="item">First Block</div>
    <div id="second" class="item">Second Block</div>
    <div id="third" class="item">Third Block</div>
  </div>

  <script src="getElementById.js"></script>
</body>
</html>
```

Waiting for the DOM to load

- Works!



Waiting for the DOM to load

- That seems… hackish. Isn't there a "right" way to do this?
- Well, its perfectly valid. `<script>` elements do not have to go in the `<head>`, although they frequently do.
- However, `<script>` elements that aren't in the `<head>` tend to get overlooked later, so we try to put them there if we can.

Events

- The web browser is an Event Driven application.
- Documents load, links are clicked, HTTP requests are made and completed.
- Each of these is an event, and we can register event listeners (function) which will be called as these events occur.
- These are called *callbacks.*

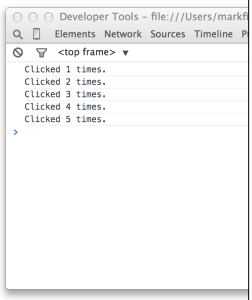
Events

- *object*.`addEventListener('event', callback);`
- The object can be any object that responds to event listeners, such as an Element, the Document, or maybe the Window.

Events

- A basic example of a ‘click’ event handler.

```
<!doctype html>
<head>
  <title>js/events.html</title>
  <link rel="stylesheet" type="text/css"
                    href="getElements.css" />
</head>

<body>
  <div id="main">
    <div id="first" class="item">First Block</div>
    <div id="second" class="item">Second Block</div>
    <div id="third" class="item">Third Block</div>
  </div>

  <script>
    clickCount = 0;
    d1 = document.getElementById('first');
    d1.addEventListener('click', function() {
      console.log("Clicked " + ++clickCount + " times.");
    });
  </script>
</body>
</html>
```



Events

- Is it really that simple? What about IE, doesn’t that always mess us up?
- Well, yes. Of course it does.
- *object*`.addEventListener()` didn’t come to IE until 9
- Earlier methods for adding event listeners were directly in markup, or via *object.event* = callback;

```
<a href="#" onclick="callbackName">Link</a>
```

`window load` Event

- There’s also a **`window`** object that the DOM API provides for us.
- The Window object supports the **`load`** event, and we can register our own callback with this.
- The **`load`** event fires once the DOM has completed loading.

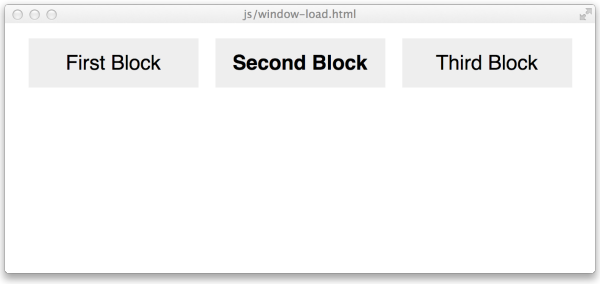
window load Event

```
<!doctype html>
<head>
  <title>js/window-load.html</title>
  <link rel="stylesheet" type="text/css"
                  href="getElements.css" />
  <script src="window-load.js"></script>
</head>

<body>
  <div id="main">
    <div id="first" class="item">First Block</div>
    <div id="second" class="item">Second Block</div>
    <div id="third" class="item">Third Block</div>
  </div>

</body>
</html>
```

```
window.addEventListener('load', function()
{
  d2 = document.getElementById('second');
  d2.classList.add('selected');
});
```

window load Event

- Works!



window load Event

- Since addEventListener doesn't work with IE 8 or older, to provide a more robust solution you'd have to do browser capabilities detection.

```
window.addEventListener('load', function()
{
  d2 = document.getElementById('second');
  d2.classList.add('selected');
});
```

`window load` Event

- IE 8 supported a different method, the *object*.`attachEvent` method.
- Even older browsers only support a single “onload” property.
- If only someone would write a library that did all this for us…

```
var ready = function(myFunciton) {
    if (window.attachEvent) {
        window.attachEvent('onload', myFunciton);
        console.log("IE");
    } else if (window.addEventListener) {
        window.addEventListener('load', myFunciton);
        console.log("Modern");
    } else {
        console.log("Legacy");
        if(window.onload) {
            var curronload = window.onload;
            var newonload = function() {
                curronload();
                myFunciton();
            };
            window.onload = newonload;
        } else {
            window.onload = myFunciton;
        }
    }
}
```

Putting Pieces Together

Demo

click-count.html

```
<!doctype html>
<head>
  <title>js/click-count.html</title>
  <link rel="stylesheet" type="text/css"
                  href="click-count.css"/>
  <script src="click-count.js"></script>
</head>

<body>
  <div id="main">
  </div>
</body>
</html>
```

click-count.html

```
var addCount = function(event) {
  var curCount = Number(this.textContent);
  curCount++;
  this.textContent = curCount.toString();
}

window.addEventListener('load', function() {
  var numBoxes = 9;
  main = document.getElementById('main');
  for (i = 0; i < numBoxes; i++) {
    var newBox = document.createElement("div");
    newBox.textContent = "0";
    newBox.addEventListener('click', addCount);
    main.appendChild(newBox);
  }
});
```

click-jump.html

click-jump.html

```
var addCount = function(event) {
  var curCount = Number(this.textContent);
  curCount++;
  this.textContent = curCount.toString();

  if (curCount == 1) {
    this.style.position = "absolute";
  }

  var max_x = window.innerWidth - 110;
  var max_y = window.innerHeight - 60;
  var newX = Math.random() * max_x;
  var newY = Math.random() * max_y;
  newX = Math.floor(newX);
  newY = Math.floor(newY);

  this.style.top = newY.toString() + "px";
  this.style.left = newX.toString() + "px";
}
```

BipIO

- Case study on copying stuff from other people.
- https://bip.io

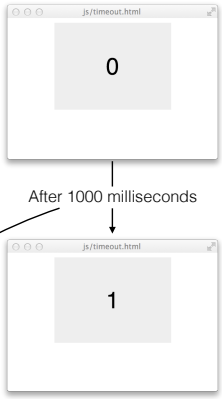
Timing Events

- Browsers implement Javascript in a threaded environment.
- Events can be queued to fire at a later time.
- *window*.`setTimeout()`
- *window*.`setInterval()`

https://developer.mozilla.org/en-US/docs/Web/API/WindowTimers

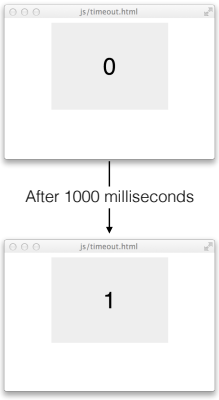
`setTimeout()`

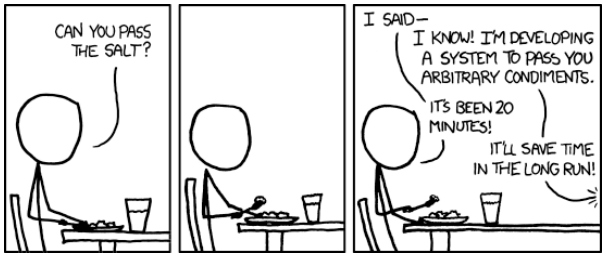
```
<!doctype html>
<head>
  <title>js/timeout.html</title>
  <link rel="stylesheet" type="text/css"
                  href="timeout.css" />
</head>

<body>
  <div id="main">0</div>

  <script>
    var counter = function() {
      var d = document.getElementById('main');
      var curCount = Number(d.textContent);
      curCount++;
      d.textContent = curCount.toString();
    }

    window.setTimeout(counter, 1000);
  </script>
</body>
</html>
```



`setInterval()`

- `setTimeout()` only fires a single time.
- To fire on an interval, use `setInterval()`, or continually call `setTimeout()`.
- Demo





Classes

Oops, sorry, there are no classes.

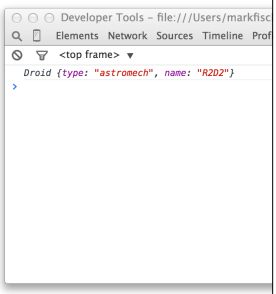
Class Like Thingies

- Javascript has no “Class” concept.
- Objects are based on building on a prototype.
- “Instances” are not tied to a particular static Class definition.
- funcitons?

functions and new

- Classes are just functions!
- Create new instances with the new keyword.

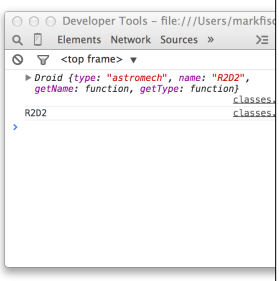
```
function Droid(type, name) {
  this.type = type;
  this.name = name;
}

var r2 = new Droid('astromech', 'R2D2');
var c3 = new Droid('protocol', 'C3PO');

console.log(r2);
```



prototypes

- Methods can be added through the special `.prototype` property of objects.

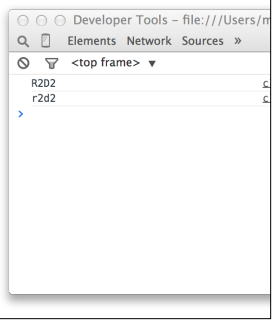
```
function Droid(type, name) {
  this.type = type;
  this.name = name;
}

Droid.prototype = {
  getName: function() { return this.name },
  getType: function() { return this.type }
}

var r2 = new Droid('astromech', 'R2D2');
var c3 = new Droid('protocol', 'C3PO');

console.log(r2);
console.log(r2.getName());
```



prototypes

- Don't like the behavior of something? Re-define it on the fly

```
function Droid(type, name) {
  this.type = type;
  this.name = name;
}

Droid.prototype = {
  getName: function() { return this.name },
  getType: function() { return this.type }
}

var r2 = new Droid('astromech', 'R2D2');
var c3 = new Droid('protocol', 'C3PO');

console.log(r2.getName());

Droid.prototype.getName =
    function() { return this.name.toLowerCase() };

console.log(r2.getName());
```



myQuery

- jQuery is a very popular Javascript toolkit which abstracts away some of the underlying complexity.
- Can we build our own simple toolkit?
- Of course we can…
- jQuery doesn't own **$**

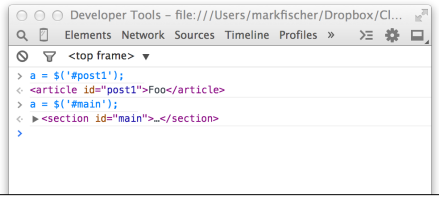
Basic Selection

- Using **`document.getElementById()`** isn't too bad, but it sure is a lot of typing.
- Can we use the **`$('selector')`** pattern?

```
var $ = function myQuery(selector) {
  // See if selector starts with a #. If so we're looking for an ID
  if (selector[0] == '#') {
    // Strip off the # sign
    var selector = selector.substring(1, selector.length);
    var element = document.getElementById(selector);
    return element;
  }
}
```

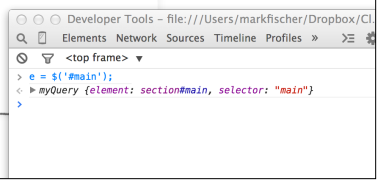
Basic Selection

```
var $ = function myQuery(selector) {
  // See if selector starts with a #. If so we're looking for an ID
  if (selector[0] == '#') {
    // Strip off the # sign
    var selector = selector.substring(1, selector.length);
    var element = document.getElementById(selector);
    return element;
  }
}
```



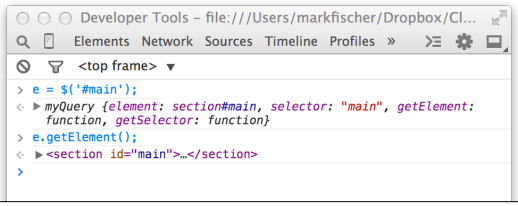
Returning Objects

```
function myQuery(selector) {
  this.element = null;
  this.selector = selector;

  // See if selector starts with a #.
  // If so we're looking for an ID
  if (selector[0] == '#') {
    // Strip off the # sign
    var selector = selector.substring(1, selector.length);
    var element = document.getElementById(selector);

    myQobj = new myQuery(selector);
    myQobj.element = element;
    return myQobj;
  }
}

var $ = myQuery;
```



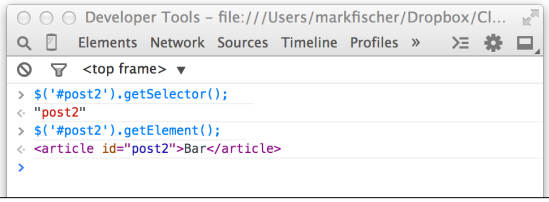
`prototype` Methods

```
myQuery.prototype = {
  getElement:       function() {
                      return this.element;
                    },
  getSelector:      function() {
                      return this.selector;
                    },
}
```



Function Chaining

- Supports function chaining.
- The return value from the function call is an object, which has methods we can call.
- Don't need intermediate variables.



jQuery

- This is basically what jQuery does.
- More methods and selector types.
- There's a lot more edge cases handled, and checks made.
- jQuery 'plugins' just add their own function calls to the jQuery `prototype` property.

`http://code.jquery.com/jquery-1.11.1.js`

And now for something moderately different