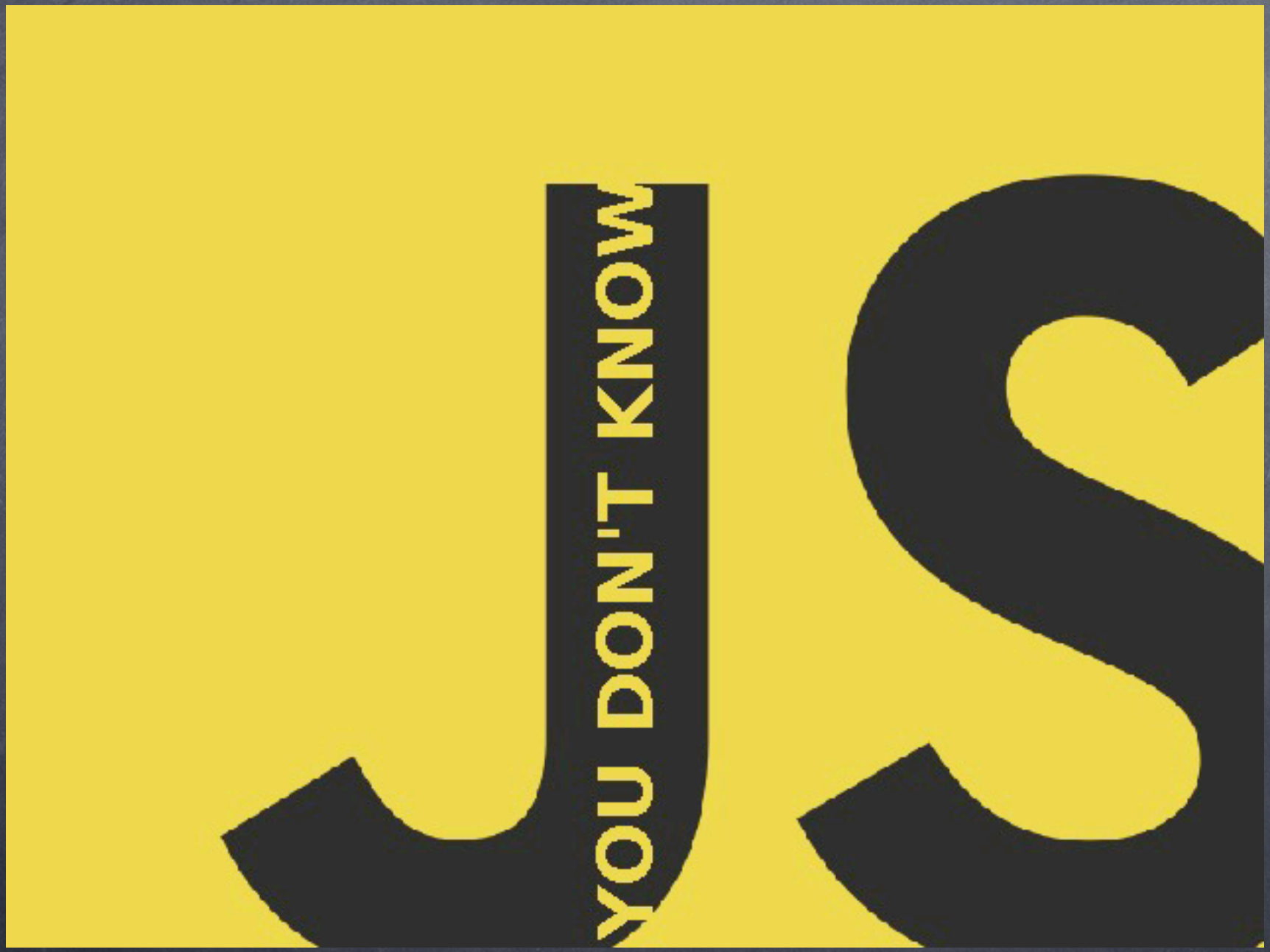
Kyle Simpson
@getify
http://getify.me

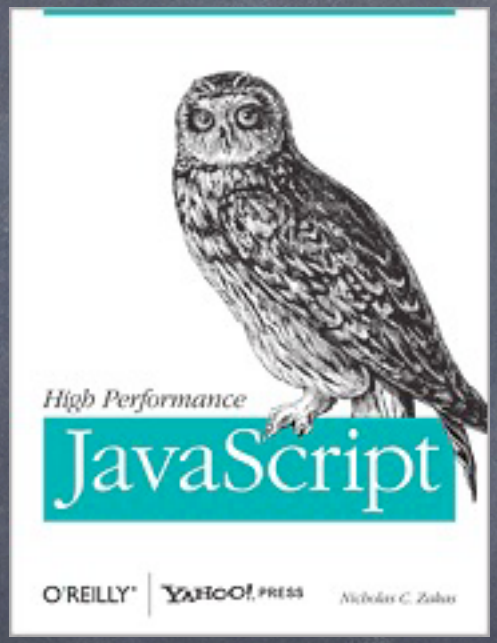
- LABjs
- grips
- asynquence

Kyle Simpson
@getify
http://getify.me

http://speakerdeck.com/getify



http://YouDontKnowJS.com


High Performance
JavaScript
O'REILLY
YAHOO! PRESS
Nicholas C. Zakas

Build Better Applications with Coding and Design Patterns
JavaScript
Patterns
O'REILLY
YAHOO! PRESS
Stoyan Stefanov

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

https://github.com/rwldrn/idiomatic.js

http://www.ecma-international.org/ecma-262/5.1/

http://wiki.ecmascript.org/doku.php?id=harmony:proposals

Advanced JavaScript

The "What you need to know" Parts

Agenda

JavaScript Background

- Brendan Eich, Netscape
- ES3
- ES5
- ES6+

Brendan Eich
Netscape, May 1995

Mocha

LiveScript

JavaScript

JavaScript History

"JS had to 'look like Java' only less so, be Java's dumb kid brother or boy-hostage sidekick. Plus, I had to be done in ten days or something worse than JS would have happened."

--Brendan Eich

ECMA-262

TC39

ECMA-262 (ES3)
December 1999

~~ECMA-262 (ES4)~~

ECMA-262 (ES5)
December 2009

ECMA-262 (ES5.1)
June 2011

"use strict";
Function#bind()
Object.create()
Object.defineProperty()
Object.keys()
get:, set:
Array#forEach()
...

JavaScript History: ES5

ECMA-262 (ES6)
aka "Harmony"

*mid 2014?

class Foo {...}

export, import, module

function foo(a, b=3) {...}

function foo(a, ...r) {...}

for-of

Map, Set, WeakMap, Proxy

Typed Arrays

...

JavaScript Future: ES6

Agenda

JavaScript Syntax

- Primitive Types
- Natives
- Coercion
- Reference vs. Value
- Surprises

- undefined
- string
- number
- boolean
- object
- function
- null

Primitive Types

```
1 typeof foo;              // "undefined"
2 typeof "foo";            // "string"
3 typeof 123;              // "number"
4 typeof true;             // "boolean"
5 typeof { a: 1 };         // "object"
6 typeof function() { alert(e); };    // "function"
```

Primitive Types (literals)

```
2
3 typeof null;     // "object" ... WAT!?
4
```

Primitive Types (literals)

Quiz

```
1 var foo;
2 typeof foo;                    // ???
3
4 var bar = typeof bar;
5 bar;                           // ???
6 typeof bar;                    // ???
7
8 typeof typeof 2;               // ???
```

Quiz

```
1 var foo;
2 typeof foo;                    // "undefined"
3
4 var bar = typeof bar;
5 bar;                           // "undefined"
6 typeof bar;                    // "string"
7
8 typeof typeof 2;               // "string"
```

- NaN ("not a number")
- Infinity, -Infinity
- null
- undefined (void)
- +0, -0

Primitive Types: special values

Negative Zero

```
1 var foo = 0 / -3;
2 foo === -0;              // true ... yay?
3 foo === 0;               // true ... doh!
4 0 === -0;                // true ... grr!
5 (0/-3) === (0/3);        // true ... sigh
6
7 foo;                     // 0 ... WAT!?
```

Negative Zero

```
1 function isNeg0(x) {
2   return x===0 && (1/x)===-Infinity;
3 }
4
5 isNeg0(0 / -3);      // true ... yay!
6 isNeg0(0 / 3);       // false ... yay!
```

NaN

```
1 var a = "a" / 2;
2
3 a;                    // NaN
4 typeof a;             // "number"
5 isNaN(a);             // true
6
7 isNaN("foo");         // true! WAT!?
```

Primitive Types: special values

NaN

```
1 if (!Number.isNaN) {
2     Number.isNaN = function(num) {
3         return (
4             typeof num === "number" &&
5             window.isNaN(num)
6         );
7     }
8 }
```

Primitive Types: special values

Quiz

```
1  var baz = 2;
2  typeof baz;                    // ???
3  var baz;
4  typeof baz;                    // ???
5  baz = null;
6  typeof baz;                    // ???
7
8  baz = "baz" * 3;
9  baz;                           // ???
10 typeof baz;                    // ???
11
12 baz = 1 / 0;
13 baz;                           // ???
14 typeof baz;                    // ???
```

Primitive Types: special values

Quiz

```
var baz = 2;
typeof baz;                    // "number"
var baz;
typeof baz;                    // "number"
baz = null;
typeof baz;                    // "object"

baz = "baz" * 3;
baz;                           // NaN
typeof baz;                    // "number"

baz = 1 / 0;
baz;                           // Infinity
typeof baz;                    // "number"
```

Primitive Types: special values

- String
- Number
- Boolean
- Function
- Object
- Array
- RegExp
- Date
- Error

Native Types?
Native Objects?

- String()
- Number()
- Boolean()
- Function()
- Object()
- Array()
- RegExp()
- Date()
- Error()

Native Functions?

Native Constructors

- new String()
- new Number()
- new Boolean()
- new Function()
- new Object()
- new Array()
- new RegExp()
- new Date()
- new Error()

Quiz

```
1  var foo = new String("foo");
2  foo;                                  // ???
3  typeof foo;                           // ???
4  foo instanceof String;                // ???
5  foo instanceof string;                // ???
6
7  foo = String("foo");
8  typeof foo;                           // ???
9
10 foo = new Number(37);
11 typeof foo;                           // ???
```

Quiz

```
var foo = new String("foo");
foo;                                  // ???
typeof foo;                           // "object"
foo instanceof String;                // true
foo instanceof string;                // false; ref error!

foo = String("foo");
typeof foo;                           // "string"

foo = new Number(37);
typeof foo;                           // "object"
```

```
1  var foo;
2
3  foo = new Array(1,2,3); // don't!
4
5  foo = [1,2,3];          // do!
6
7  foo = new Object();     // don't!
8  foo.a = 1;
9  foo.b = 2;
10 foo.c = 3;
11
12 foo = { a:1, b:2, c:3 };// do!
```

Natives: literals

```
1 var foo;
2
3 foo = new RegExp("a*b","g");
4
5 foo = /a*b/g;
6
7 foo = new Date();
8
9 // no date literal!
```

Natives: literals

Explicit

Implicit

Coercion

Explicit: it's obvious from the code that you're doing it.

Explicit Coercion

string $\longleftrightarrow$ number

Explicit Coercion

```
var foo = "123";
var baz = parseInt(foo,10);
baz;                          // 123

baz = Number(foo);
baz;                          // 123

baz = +foo;                   // explicit?
baz;                          // 123

baz = 456;
foo = baz.toString();
foo;                          // "456"

foo = String(baz);
foo;                          // "456"
```

Explicit Coercion

$$* \longrightarrow \text{boolean}$$

Explicit Coercion

Falsy	Truthy
“”	“foo”
0, +0, -0	23
null	{ a:1 }
NaN	[1,3]
false	true
undefined	function(){..}
	...

Explicit Coercion

```
1  var foo = "123";
2  var baz = Boolean(foo);
3  baz;                                  // true
4
5  baz = !!foo;
6  baz;                                  // true
7
8  // explicitly implicit!
9  baz = foo ? true : false;
10 baz;                                  // true
```

Explicit Coercion

```
1 var now = +new Date();
2 // now = Date.now(); // ES5 only!
3
4 var foo = "foo";
5 // ~N -> -(N+1)
6 if (~foo.indexOf("f")) {
7     alert("Found it!");
8 }
```

Explicit Coercion

Implicit: happens as a side effect of some other operation

Implicit Coercion

Implicit: evil?

```
1  var foo = "123";
2  var baz = foo - 0;
3  baz;                    // 123
4
5  baz = foo - "0";
6  baz;                    // 123
7
8  baz = foo / 1;
9  baz;                    // 123
10
11 baz = 456;
12 foo = baz + "";
13 foo;                    // "456"
14
15 foo = baz - "";
16 foo;                    // 456 ... WAT!?
```

Implicit Coercion

```
1  var foo = "123";
2  if (foo) {                          // yup
3      alert("Sure.");
4  }
5
6  foo = 0;
7  if (foo) {                          // nope
8      alert("Right.");
9  }
10 if (foo == false) {                 // yup
11     alert("Yeah.");
12 }
13
14 var baz = foo || "foo";
15 baz;                                // "foo"
```

Implicit Coercion

```
1  var foo = "123";
2  if (foo == true) {              // nope!
3      alert("WAT!?");
4  }
5
6  foo = [];
7  if (foo) {                      // yup
8      alert("Sure.");
9  }
10 if (foo == false) {             // yup!
11     alert("WAT!?");
12 }
```

Implicit Coercion

```
1  "0" == null;          // false
2  "0" == undefined;     // false
3  "0" == false;         // true -- OOPS!!!
4  "0" == NaN;           // false
5  "0" == 0;             // true
6  "0" == "";            // false
7
8  false == null;        // false
9  false == undefined;   // false
10 false == NaN;         // false
11 false == 0;           // true -- OOPS!!!
12 false == "";          // true -- OOPS!!!
13
14 "" == null;           // false
15 "" == undefined;      // false
16 "" == NaN;            // false
17 "" == 0;              // true -- OOPS!!!
18
19 0 == null;            // false
20 0 == undefined;       // false
21 0 == NaN;             // false
```

Implicit Coercion

```
1  [] == ![]; // true :(
2
3  [] == false; // true :(
4
5  [] == ""; // true :(
6
7  0 == ""; // true :(
8
9  !!"123"; // true :)
10 "123" == true; // false  :(
```

Implicit Coercion

Ask Yourself:

1. Can the value ever be 0 or “”?
2. Can the value ever be [] or false?

Primitive $\longleftrightarrow$ Native

Implicit Coercion

```
1 var foo = "123";
2 foo.length;                    // 3
3
4 foo.charAt(2);                 // "3"
5
6 foo = new String("123");
7 var baz = foo + "";
8 typeof baz;                    // "string"
```

Implicit Coercion

"Any sufficiently advanced technology is indistinguishable from magic."

--Arthur C. Clarke

Implicit Coercion

"Any sufficiently complex technology is indistinguishable from magic."

--many devs

Implicit Coercion

"Any sufficiently confusing technology is indistinguishable from magic."

--many devs

Implicit Coercion

== VS. ===

Implicit Coercion

~~== checks value~~

~~=== checks value and type~~

== allows coercion

=== disallows coercion

Implicit Coercion

```
1  var foo = [];
2  var baz = "";
3  if (foo == baz) {          // yup!
4      alert("Doh!");
5  }
6  if (foo === baz) {         // nope
7      alert("Phew.");
8  }
9
10 foo = 0;
11 if (foo == "") {           // yup!
12     alert("Argh!");
13 }
14 if (foo === "") {          // nope
15     alert("Phew.");
16 }
```

Implicit Coercion: == vs. ===

but... but...

Implicit Coercion: == vs. ===

```
1  var foo = "3";
2  if (foo === 3 || foo === "3") { // yup
3      alert("Thanks, but...");
4  }
5
6  if (foo == 3) {                 // yup!
7      alert("That's nicer!");
8  }
9
10 if (typeof foo === "string") {  // yup
11     alert("typeof always returns a string");
12 }
```

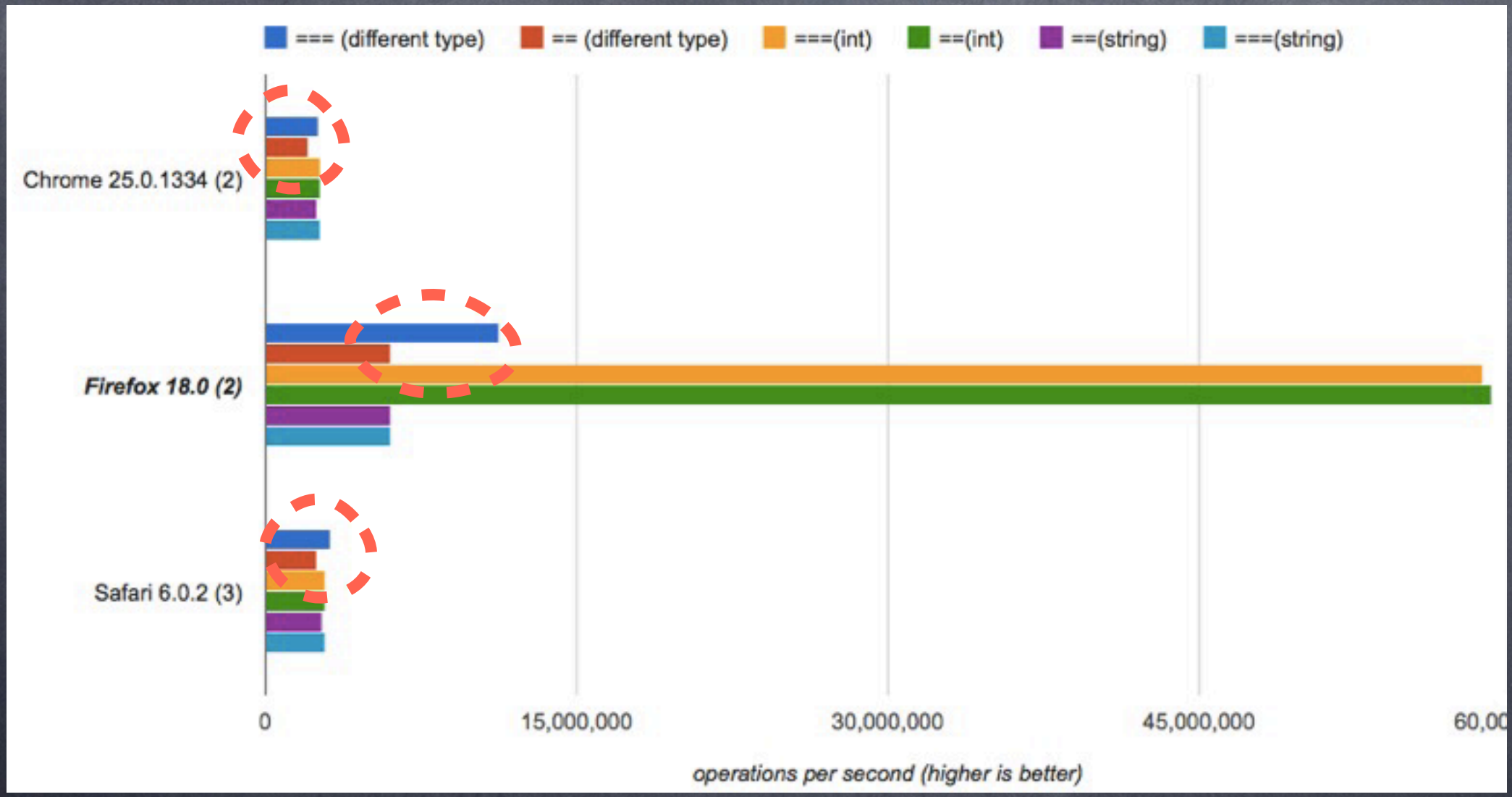
Implicit Coercion: == OK sometimes?

```
1  var foo;
2  if (foo == null) {        // yup!
3      alert("Thanks!");
4  }
5
6  foo = null;
7  if (foo == null) {        // yup
8      alert("Thanks, again!");
9  }
10
11 foo = false;
12 if (foo == null) {        // nope!
13     alert("Phew!");
14 }
```

Implicit Coercion: == OK sometimes?

What about the performance of == or ===?

http://jsperf.com/triple-equals-vs-double-equals/5



Implicit Coercion: == vs. === performance

7

- If the types compared are the same, ***they are identical***. That is to say they use ***the exact same algorithm***.
- If the types are *different*, then performance is irrelevant. Either you need type coercion, or you don't. If you don't need it, don't use `==` because the result you get may be unexpected.

share | edit | flag

answered **Nov 8 '11 at 1:18**

user1034768

add comment

Implicit Coercion: == vs. === performance

#FUD: using == in your code is dangerous. Avoid it!

Implicit Coercion: == vs. ===

#protip: use === where it's safer and use == where it's more helpful.

#FUD: JavaScript's implicit coercion is a flaw in the design of the language. Avoid it!

#protip: use explicit coercion where it's safer and use implicit coercion where it's more helpful.

http://jscoercion.qfox.nl/

http://webreflection.blogspot.com/2010/10/javascript-coercion-demystified.html

Coercion

(exercise #1: 5min)

Reference vs. Value

Variables that hold simple primitives (string, number, boolean, undefined, null) are held by value.

Assignments are by-copy.

Variables that hold anything else are held by reference.

Assignments are by-reference.

```
1  function foo(obj) {
2      obj.a = "foo";
3      obj.b = [1,2,3];
4      obj = { a: "baz", b: [4,5,6] };
5  }
6
7  var o = { a: "bar", b: [7,8,9] };
8  var a = o.a;
9  var b = o.b;
10
11 foo(o);
12
13 o.a;          // "foo"
14 o.b;          // [1,2,3]
15 a;            // "bar"
16 b;            // [7,8,9]
```

Reference vs. Value

```
var obj = { b: [1,2,3] };
var b = obj.b;

obj.b;                  // [1,2,3]
b;                      // [1,2,3]

obj.b = null;

obj.b;                  // null
b;                      // [1,2,3]

b = null;

obj.b;                  // null
b;                      // null
```

Reference vs. Value

http://wtfjs.com

```
1
2 parseInt("08");      // 0 ... WAT!?
3
4 parseInt(1/0,19);    // 18 ... WAT!?
5
```

Surprises

```
1 function foo(bar) {
2     return
3         bar + 2;
4 }
5
6 foo(2);       // undefined ... WAT!?
```

Surprises

```
1 42.;     // valid syntax!
2
3 (42).toFixed(2); // "42.00"
4
5 42.toFixed(2); // SyntaxError
6
7 42.888.toFixed(2); // "42.89"
8
9 42..toFixed(2); // "42.00"
```

Surprises

```
1 function hello(what) {
2     what = "world";
3     return "Hello, " + arguments[0] + "!";
4 }
5
6 hello("friends");   // Hello, world!
```

Surprises

```
1 // false -- hmmm...
2 String("abc") instanceof String;
3
4 // true
5 (new String("abc")) instanceof String;
6
7 // true -- wait, WAT!?
8 String("abc") == (new String("abc"));
```

Surprises

```
1
2  3 > 2 > 1;      // false ... WAT!?
3
```

Surprises

```
1
2  Array(5).join("wat" - 1) + " Batman!";
3  // NaNNaNNaNNaN Batman!
4
```

Surprises

```
1  Array(3).length === 3; // true
2
3  Array(3)[0] === Array(3)[1] ===
4      Array(3)[2] === undefined; // true
5
6  [undefined,undefined,undefined].toString(); // ,,
7  Array(3).toString(); // ,,
8
9  [undefined,undefined,undefined].join("+"); // ++
10 Array(3).join("+"); // ++
11
12 [undefined,undefined,undefined].map(
13     function(){ return "+" }
14 ); // ["+","+","+"]
15 Array(3).map(
16     function(){ return "+" }
17 ); // [] !?!?!?
18
19 Array(3); // [] or "[undefined x 3]" (in Chrome console)
```

Surprises

```
Array.apply(null,Array(3)); // [undefined,undefined,undefined]

Array.apply(null,Array(3)).map(
    function(){ return "+" }
); // ["+","+","+"]

Array.apply(null,{ length: 3 }).map(
    function(){ return "+" }
); // ["+","+","+"]
```

Surprises

Please use JavaScript responsibly.

If you're going to write JavaScript, appreciate it.

Agenda

Optimizing DOM & Events

- CSS Selectors
- DOM Management
- Event Management

```
1  <ul>
2      <li id="foo">
3          <p>Bond, James Bond</p>
4      </li>
5      <li>
6          <p>Never say never again</p>
7      </li>
8      <li class="bar">
9          <p>Shaken, not stirred</p>
10     </li>
11     <li class="bar">
12         <p>Hello, Moneypenny</p>
13     </li>
14 </ul>
```

CSS Selectors

```
1 #foo { ... }
2
3 li.bar { ... }
4
5 #foo ~ li.bar > p { ... }
```

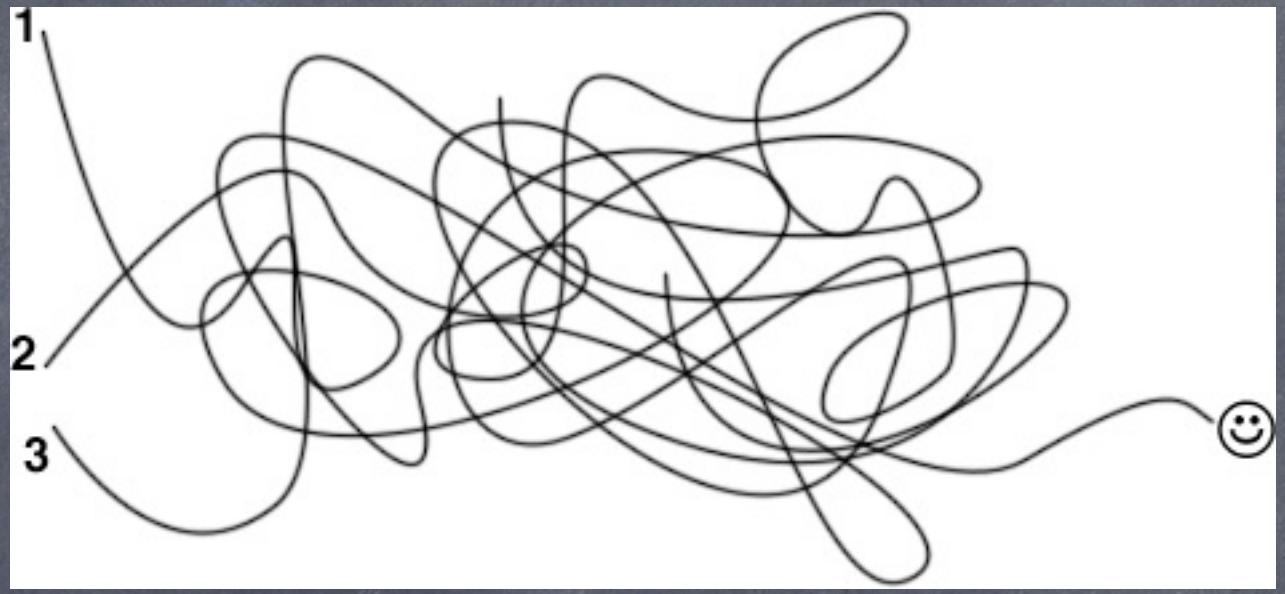
CSS Selectors

```
1 $("#foo ~ li.bar > p")
2 .addClass("highlighted")
3 .attr({
4     title: "Look at me!"
5 });
```

CSS Selectors

Left-to-Right
Right-to-Left

http://csswizardry.com/2011/09/writing-efficient-css-selectors/



CSS Selectors

```
1 $("#foo ~ li.bar > p")
2 .addClass("highlighted")
3 .attr({
4     title: "Look at me!"
5 });
```

CSS Selectors: under-specified?

```
1 $("ul li#foo ~ li.bar > p")
2 .addClass("highlighted")
3 .attr({
4     title: "Look at me!"
5 });
```

CSS Selectors: over-specified

```
1 var $bars = $("#foo ~ li.bar");
2
3 // later
4 $("> p", $bars)
5 .addClass("highlighted")
6 .attr({
7     title: "Look at me!"
8 });
```

CSS Selectors: jQuery "context"

```
1 var $bars = $("#foo ~ li.bar");
2
3 // later
4 $bars.children("p")
5 .addClass("highlighted")
6 .attr({
7     title: "Look at me!"
8 });
```

CSS Selectors: jQuery children

```
1 var $bars = $("#foo ~ li.bar");
2
3 // later
4 $bars.children("p")
5 .addClass("highlighted")
6 .attr({
7     title: "Look at me!"
8 });
```

jQuery Iterations

```
1  var $bars = $("#foo ~ li.bar");
2
3  // later
4  $bars.children("p").each(function(){
5      $(this)
6      .addClass("highlighted")
7      .attr({
8          title: "Look at me!"
9      });
10 });
```

jQuery Iterations

Quiz

```
1  <p id="p1">
2  Hello <em>world</em>!
3  </p>
4  <p class="p">
5  <strong>Now is the <em>time</em></strong>...
6  </p>
7  <script>
8  // find only these <em>'s
9   ??? .each(function(){
10      $(this)
11      .addClass("highlighted")
12      .attr({
13          title: "Look at me!"
14      });
15 });
16 </script>
```

Quiz

```
1  <p id="p1">
2  Hello <em>world</em>!
3  </p>
4  <p class="p">
5  <strong>Now is the <em>time</em></strong>...
6  </p>
7  <script>
8  // find only these <em>'s
9  $("#p1 > em, .p > strong > em").each(function(){
10     $(this)
11     .addClass("highlighted")
12     .attr({
13         title: "Look at me!"
14     });
15 });
16 </script>
```

(exercise #2: 10min)

DOM: toll road

```
1 for (var i=1; i<6; i++) {
2     $("h" + i)
3     .addClass("header");
4 }
```

DOM Management: lookups

```
1 var h = [];
2 for (var i=1; i<6; i++) {
3     h.push("h" + i);
4 }
5
6 $(h.join(","))
7 .addClass("header");
```

DOM Management: lookups

```
1 var mobsters = ["Lou","Frankie","Max"];
2 var $li;
3
4 for (var i=0; i<mobsters.length; i++) {
5     $li = $("<li></li>")
6     .text(mobsters[i]);
7
8     $("#hit_list").append($li);
9 }
```

DOM Management: lookups

```
1  var mobsters = ["Lou","Frankie","Max"];
2  var $li;
3  var $hit_list = $("#hit_list");
4
5  for (var i=0; i<mobsters.length; i++) {
6      $li = $("<li></li>")
7      .text(mobsters[i]);
8
9      $hit_list.append($li);
10 }
```

DOM Management: lookups

```
1  var mobsters = ["Lou","Frankie","Max"];
2  var $li;
3  var $hit_list = $("#hit_list");
4
5  for (var i=0; i<mobsters.length; i++) {
6      $li = $("<li></li>")
7      .text(mobsters[i]);
8
9      $hit_list.append($li);
10 }
```

DOM Management: insertions

```
1  var mobsters = ["Lou","Frankie","Max"];
2  var $li;
3  var $lis;
4  var $hit_list = $("#hit_list");
5
6  for (var i=0; i<mobsters.length; i++) {
7      $li = $("<li></li>")
8      .text(mobsters[i]);
9
10     if (!$lis) { $lis = $($li); }
11     else { $lis = $lis.add($li); }
12 }
13
14 $hit_list.append($lis);
```

DOM Management: insertions

```
1  var mobsters = ["Lou","Frankie","Max"];
2  var lis = [];
3  var $hit_list = $("#hit_list");
4
5  for (var i=0; i<mobsters.length; i++) {
6      lis.push("<li>" + mobsters[i] +
7          "</li>");
8  }
9
10 $hit_list.html(lis.join(""));
```

DOM Management: insertions

Event Management

```
1  var mobsters = ["Lou","Frankie","Max"];
2  var $li;
3  var $hit_list = $("#hit_list");
4
5  for (var i=0; i<mobsters.length; i++) {
6      $li = $("<li></li>")
7      .text(mobsters[i]);
8
9      $hit_list.append($li);
10 }
```

Event Management

```
1 var $hit_list = $("#hit_list");
2
3 $hit_list.children("li")
4 .bind("click",function(evt){
5     var who = $(evt.target).text();
6     alert("You just shot " + who);
7 });
```

Event Management

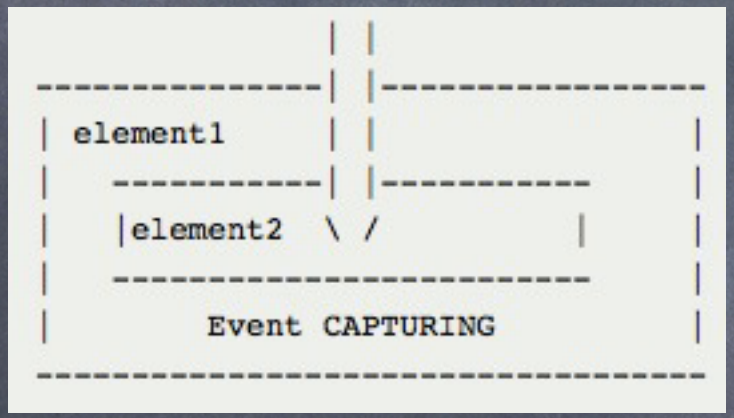
Code Me

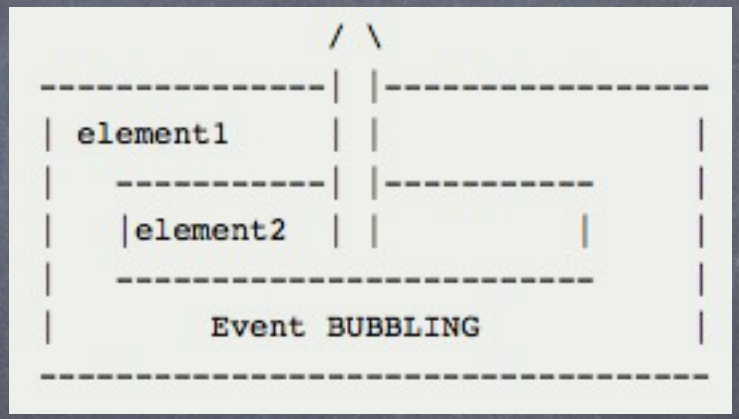
Event Propagation

Capturing

Bubbling

http://www.quirksmode.org/js/events_order.html





Event Management

```
1 var $hit_list = $("#hit_list");
2
3 $hit_list
4 .bind("click",function(evt){
5     var who = $(evt.target).text();
6     alert("You just shot " + who);
7 });
```

Event Management: delegation

```
1 var $hit_list = $("#hit_list");
2
3 $hit_list
4 .bind("click",function(evt){
5     if ($(evt.target).is("li")) {
6         var who = $(evt.target).text();
7         alert("You just shot " + who);
8     }
9 });
```

Event Management: delegation

```
1 var $hit_list = $("#hit_list");
2
3 $hit_list
4 .on("click","> li",function(evt){
5     var who = $(evt.target).text();
6     alert("You just shot " + who);
7 });
```

Event Management: delegation

Code Me

focus

change

Event Management: capturing

```
1 var $hit_list = $("#hit_list");
2
3 $hit_list
4 .bind("focus",function(evt){
5     alert("Watch out!");
6 });
```

Event Management: capturing

```
1  // cheat :)
2  $hit_list.find("li").append(
3      $("<input>")
4  );
5
6  $hit_list[0].addEventListener(
7      "focus",
8      function(evt){
9          console.log("Watch out!");
10     },
11     /*capturing=*/true
12 );
```

Event Management: capturing

Code Me

http://fuelyourcoding.com/jquery-events-stop-misusing-return-false/

Event Management: canceling

```
1  $("#nav").on(
2      "click",
3      "> a",
4      function(evt){
5          // do something useful!
6
7          // prevent default
8          return false;
9      }
10 );
```

Event Management: canceling

```
1  $("#nav").on(
2      "click",
3      "> a",
4      function(evt){
5          // do something useful!
6
7          // prevent default
8          evt.preventDefault();
9      }
10 );
```

Event Management: canceling

```
1  $("#nav").on(
2      "click",
3      "> a",
4      function(evt){
5          // do something useful!
6
7          // prevent propagations
8          evt.stopPropagation();
9          evt.stopImmediatePropagation();
10     }
11 );
```

Event Management: canceling

```
1 $("#nav")[0].addEventListener(
2     "click",
3     function(evt){
4         evt.preventDefault();
5         evt.stopPropagation();
6         evt.stopImmediatePropagation();
7     },
8     /*capturing=*/true
9 );
```

Event Management: canceling

```
1 $("#nav")[0].addEventListener(
2     "focus",
3     function(evt){
4         console.log("cancelable: " +
5             evt.cancelable // false :(
6         );
7     },
8     /*capturing=*/true
9 );
```

Event Management: canceling

(exercise #3: 20min)

```
1  $("#nav").on(
2      "disabled", // custom event!
3      "> a",
4      function(evt){
5          $(evt.target)
6          .addClass("disabled");
7      }
8  );
9
10 // later
11 $("#nav > a").trigger("disabled");
```

Event Management: custom DOM events

https://github.com/hij1nx/EventEmitter2
https://github.com/creationix/eventemitter-browser

```
1 var EVT = new EventEmitter2();
2
3 // later
4 EVT.on("foobar",function(){
5     console.log("foobar fired!");
6 });
7
8 // even later
9 EVT.emit("foobar");
```

Event Management: custom JS events

Agenda

Scope, Closures

- Nested Scope
- Hoisting
- this
- Closure

Scope: where to look for things

JavaScript has
function scope only*

```
1  var foo = "bar";
2
3  function bar() {
4      var foo = "baz";
5  }
6
7  function baz(foo) {
8      foo = "bam";
9      bam = "yay";
10 }
```

Scope

```
1  var foo = "bar";
2
3  function bar() {
4      var foo = "baz";
5
6      function baz(foo) {
7          foo = "bam";
8          bam = "yay";
9      }
10     baz();
11 }
12
13 bar();
14 foo;          // ???
15 bam;          // ???
16 baz();        // ???
```

Code Me

Scope

```
1  var foo = "bar";
2
3  function bar() {
4      var foo = "baz";
5
6      function baz(foo) {
7          foo = "bam";
8          bam = "yay";
9      }
10     baz();
11 }
12
13 bar();
14 foo;          // "bar"
15 bam;          // "yay"
16 baz();        // Error!
```

Scope

```
1  var foo = function bar() {
2      var foo = "baz";
3
4      function baz(foo) {
5          foo = bar;
6          foo;     // function...
7      }
8      baz();
9  };
10
11 foo();
12 bar();        // Error!
```

Scope: function scope?

Code Me

```
1  var foo;
2
3  try {
4      foo.length;
5  }
6  catch (err) {
7      console.log(err); // TypeError
8  }
9
10 console.log(err); // ReferenceError
```

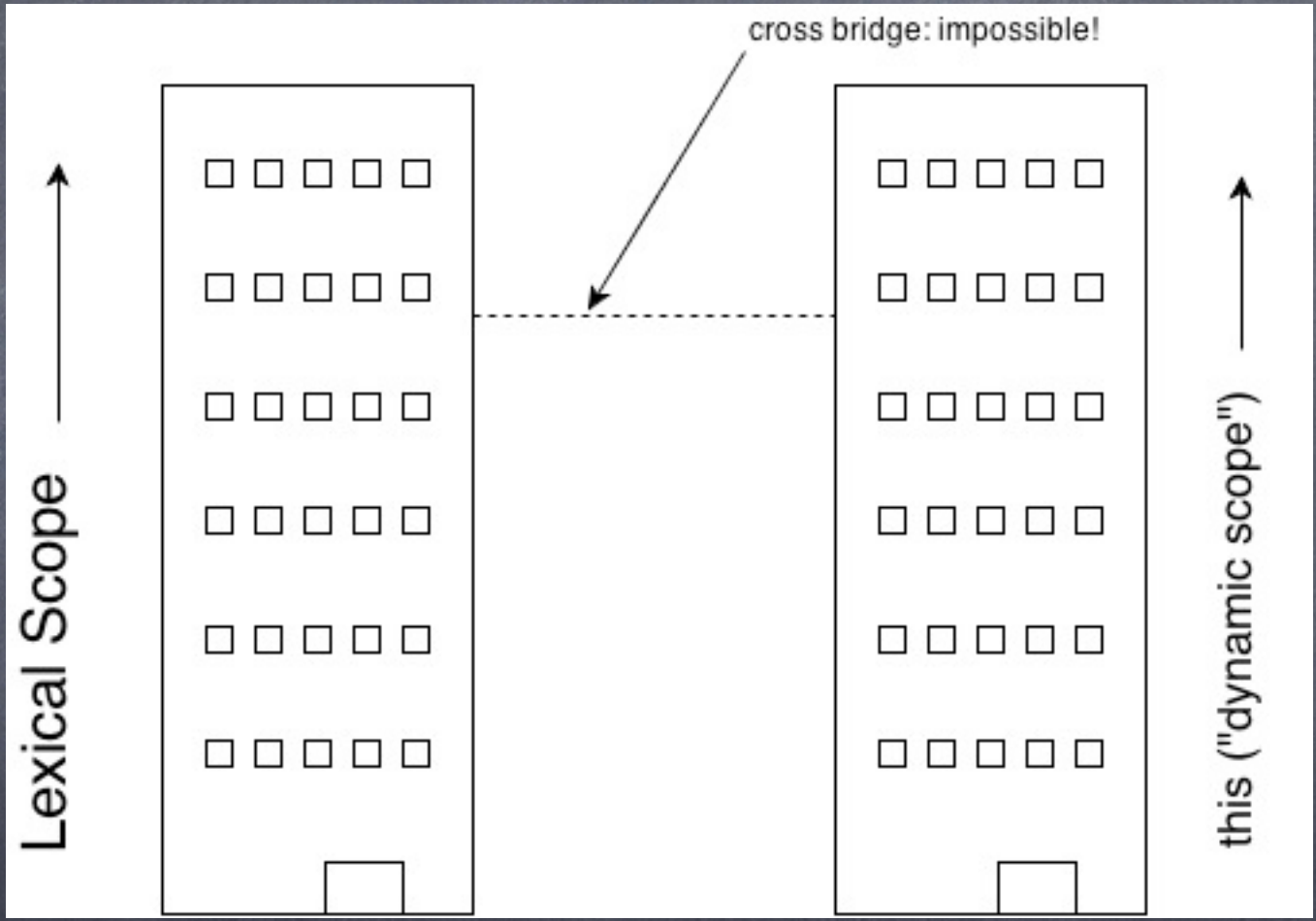
Scope: block scope?

Code Me

lexical scope

dynamic scope

Scope



Scope

```
1 function foo() {
2     var bar = "bar";
3
4     function baz() {
5         console.log(bar); // lexical!
6     }
7     baz();
8 }
9 foo();
```

Scope: lexical

```
1 var bar = "bar";
2
3 function foo(str) {
4     eval(str);  // cheating!
5     console.log(bar); // 42
6 }
7
8 foo("var bar = 42;");
```

Scope: WAT!?

```
1  var bar = "bar";
2  var obj = {
3      a: { bar: "bam" },
4      b: { baz: "baz" }
5  };
6
7  function foo(o,k) {
8      with (o[k]) { bar = 42; }
9  }
10
11 foo(obj,"a");
12 bar;              // "bar"
13 obj.a.bar;        // 42
14
15 foo(obj,"b");
16 bar;              // 42
17 obj.b.bar;        // undefined
```

Scope: WAT!?

IIFE

```
var foo = "foo";

(function(){

    var foo = "foo2";
    console.log(foo);    // "foo2"

})();

console.log(foo);    // "foo"
```

http://benalman.com/news/2010/11/immediately-invoked-function-expression/

```
1  var foo = "foo";
2
3  (function(bar){
4
5      var foo = bar;
6      console.log(foo);    // "foo"
7
8  })(foo);
9
10 console.log(foo);    // "foo"
```

Function Scope

Block Scope

let (ES6+)

Block Scope

```
1 function foo() {
2     var bar = "bar";
3     for (let i=0; i<bar.length; i++) {
4         console.log(bar.charAt(i));
5     }
6     console.log(i); // ReferenceError
7 }
8
9 foo();
```

Block Scope: let

```
1  function foo(bar) {
2      if (bar) {
3          let baz = bar;
4          if (baz) {
5              let bam = baz;
6          }
7          console.log(bam); // Error
8      }
9      console.log(baz); // Error
10 }
11
12 foo("bar");
```

Block Scope: let

```
1 function foo(bar) {
2     let (baz = bar) {
3         console.log(baz); // "bar"
4     }
5     console.log(baz); // Error
6 }
7
8 foo("bar");
```

Block Scope: let

```
1 function foo(bar) {
2     /*let*/ { let baz = bar;
3         console.log(baz); // "bar"
4     }
5     console.log(baz); // Error
6 }
7
8 foo("bar");
```

https://gist.github.com/getify/5285514

Block Scope: let

```
1 let (foo) {
2     foo = "foo";
3     console.log("foo");
4 }
5
6 foo; // Reference Error!
```

https://github.com/getify/let-er

Block Scope: let

```
1 try{throw void 0}catch
2 /*let*/(foo) {
3     foo = "foo";
4     console.log(foo);
5 }
6
7 foo; // Reference Error!
```

https://github.com/getify/let-er

Block Scope: let

Code Me

dynamic scope

```
1  // theoretical dynamic scoping
2  function foo() {
3      console.log(bar); // dynamic!
4  }
5
6  function baz() {
7      var bar = "bar";
8      foo();
9  }
10
11 baz();
```

Scope: dynamic!?!?

Quiz

1. What type of scoping rule(s) does JavaScript have? Exceptions?
2. What are the different ways you can create a new scope?
3. What's the difference between undeclared and undefined?

Scope: hoisting

```
1 a;                // ???
2 b;                // ???
3 var a = b;
4 var b = 2;
5 b;                // 2
6 a;                // ???
```

Scope: hoisting

Code Me

```
1 var a;
2 var b;
3 a;                    // ???
4 b;                    // ???
5 a = b;
6 b = 2;
7 b;                    // 2
8 a;                    // ???
```

Scope: hoisting

```
1  var a = b();
2  var c = d();
3  a;                    // ???
4  c;                    // ???
5
6  function b() {
7      return c;
8  }
9
10 var d = function() {
11     return b();
12 };
```

Scope: hoisting

```
1  function b() {
2      return c;
3  }
4  var a;
5  var c;
6  var d;
7  a = b();
8  c = d();
9  a;                  // ???
10 c;                  // ???
11 d = function() {
12     return b();
13 };
```

Scope: hoisting

```
1  foo(); // "foo"
2
3  var foo = 2;
4
5  function foo() {
6      console.log("bar");
7  }
8
9  function foo() {
10     console.log("foo");
11 }
```

Hoisting: functions first

Code Me

```
1  a(1);          // ???
2
3  function a(foo) {
4      if (foo > 20) return foo;
5      return b(foo+2);
6  }
7  function b(foo) {
8      return c(foo) + 1;
9  }
10 function c(foo) {
11     return a(foo*2);
12 }
```

Hoisting: recursion

```
1 function foo(bar) {
2     if (bar) {
3         console.log(baz); // ReferenceError
4         let baz = bar;
5     }
6 }
7
8 foo("bar");
```

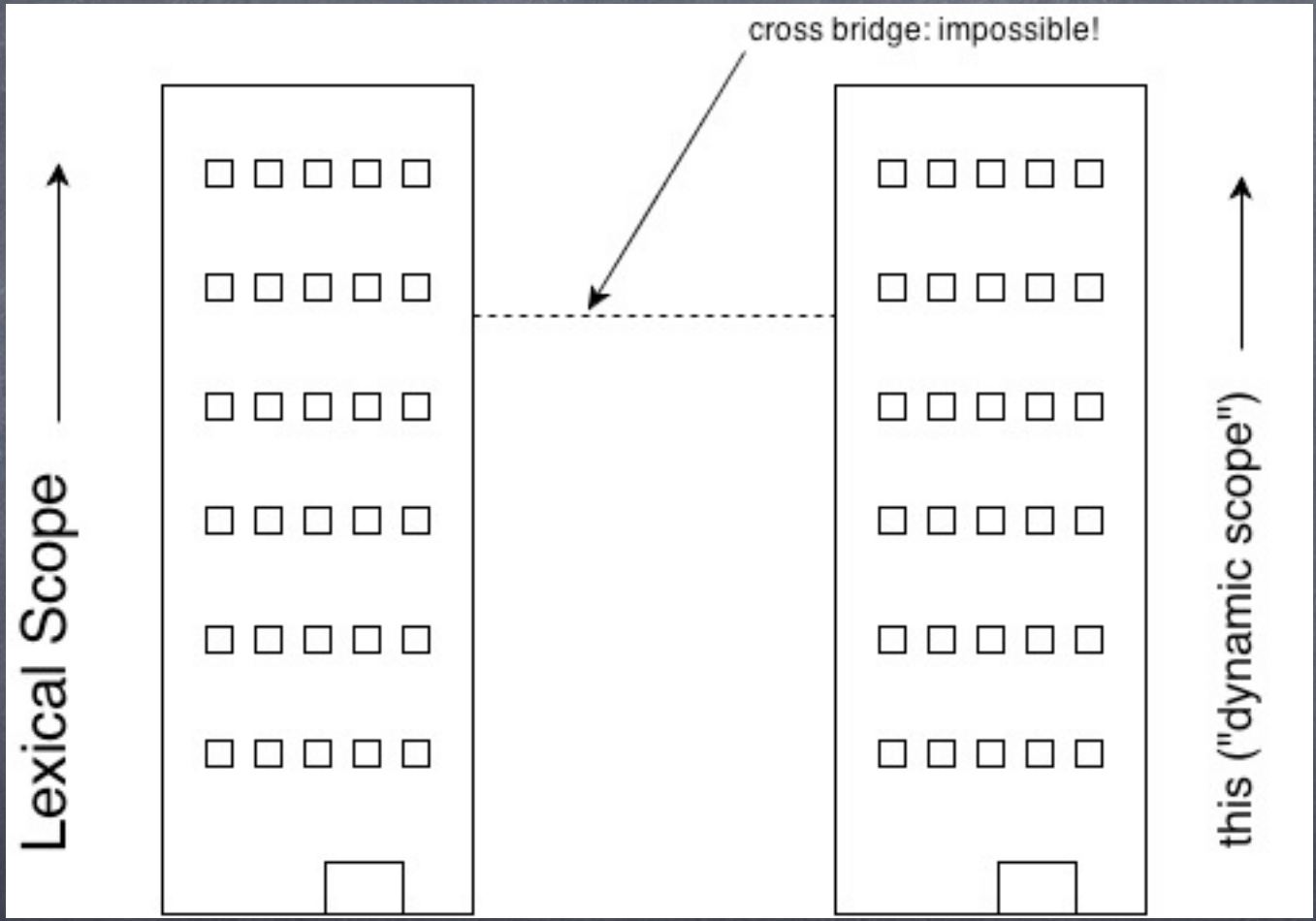
Hoisting: let gotcha

this

Every function, **while executing**, has a reference to its current execution context, called this.

Remember lexical scope vs. dynamic scope?

JavaScript's version of "dynamic scope" is this.



Scope

```
1  function foo() {
2      console.log(this.bar);
3  }
4
5  var bar = "bar1";
6  var o2 = { bar: "bar2", foo: foo };
7  var o3 = { bar: "bar3", foo: foo };
8
9  foo();                  // "bar1"
10 o2.foo();               // "bar2"
11 o3.foo();               // "bar3"
```

this: implicit & default binding

Code Me

```
1  var o1 = {
2      bar: "bar1",
3      foo: function() {
4          console.log(this.bar);
5      }
6  };
7  var o2 = { bar: "bar2", foo: o1.foo };
8
9  var bar = "bar3";
10 var foo = o1.foo;
11
12 o1.foo();              // "bar1"
13 o2.foo();              // "bar2"
14 foo();                 // "bar3"
```

this: implicit & default binding

Code Me

```
1  function foo() {
2      var bar = "bar1";
3      baz();
4  }
5  function baz() {
6      console.log(this.bar);
7  }
8
9  var bar = "bar2";
10 foo();              // ???
```

this: binding confusion

```
1  function foo() {
2      var bar = "bar1";
3      this.baz = baz;
4      this.baz();
5  }
6  function baz() {
7      console.log(this.bar);
8  }
9
10 var bar = "bar2";
11 foo();              // ???
```

this: binding confusion

```
1 function foo() {
2     console.log(this.bar);
3 }
4
5 var bar = "bar1";
6 var obj = { bar: "bar2" };
7
8 foo();                    // "bar1"
9 foo.call(obj);            // "bar2"
```

this: explicit binding

Code Me

```
1  function foo() {
2      console.log(this.bar);
3  }
4
5  var obj = { bar: "bar" };
6  var obj2 = { bar: "bar2" };
7
8  var orig = foo;
9  foo = function(){ orig.call(obj); };
10
11 foo();            // "bar"
12 foo.call(obj2); // ???
```

this: hard binding

Code Me

```
1  function bind(fn,o) {
2      return function() {
3          fn.call(o);
4      };
5  }
6  function foo() {
7      console.log(this.bar);
8  }
9
10 var obj = { bar: "bar" };
11 var obj2 = { bar: "bar2" };
12
13 foo = bind(foo,obj);
14
15 foo();            // "bar"
16 foo.call(obj2); // ???
```

this: hard binding

Code Me

```
1  if (!Function.prototype.bind2) {
2      Function.prototype.bind2 =
3          function(o) {
4              var fn = this; // the function!
5              return function() {
6                  return fn.apply(o,arguments);
7              };
8          };
9  }
10
11 function foo(baz) {
12     console.log(this.bar + " " + baz);
13 }
14
15 var obj = { bar: "bar" };
16 foo = foo.bind2(obj);
17
18 foo("baz");          // "bar baz"
```

this: hard binding

Code Me

https://developer.mozilla.org/en-US/docs/JavaScript/Reference/Global_Objects/Function/bind

```
1 function foo(baz,bam) {
2     console.log(this.bar + " " + baz +
3         " " + bam);
4 }
5
6 var obj = { bar: "bar" };
7 foo = foo.bind(obj,"baz");  // ES5 only!
8
9 foo("bam");                 // "bar baz bam"
```

this: hard binding

Code Me

```
1 function foo() {
2     this.baz = "baz";
3     console.log(this.bar + " " + baz);
4 }
5
6 var bar = "bar";
7 var baz = new foo();    // ???
```

this: new

Code Me

```
1  function something() {
2      this.hello = "hello";
3      console.log(this.hello,this.who);
4  }
5
6  var who = "global", foobar, bazbam,
7      obj1 = { who: "obj1", something: something },
8      obj2 = { who: "obj2" };
9
10 something(); // "hello"  "global"
11 console.log(hello); // "hello"          <-- OOPS!!!
12
13 obj1.something(); // "hello"  "obj1"
14 console.log(obj1.hello); // "hello"
15
16 obj1.something.call(obj2); // "hello"  "obj2"
17 console.log(obj2.hello); // "hello"
18
19 foobar = something.bind(obj2);
20 foobar(); // "hello"  "obj2"
21 foobar.call(obj1); // "hello"  "obj2"
22
23 bazbam = new something(); // "hello"  "undefined"
24 console.log(bazbam.hello); // "hello"
25
26 bazbam = new obj1.something(); // "hello"  "undefined"
27 bazbam = new foobar(); // "hello"  "undefined"
```

this: new, order of precedence

1. Was the function called with `new`?
2. Was the function called with `call` or `apply` specifying an explicit this?
3. Was the function called via a containing/owning object (context)?
4. DEFAULT: global object (except strict mode)

this: determination

Quiz

1. What determines which object a function's this points to? What's the default?
2. How do you "borrow" a function by implicit assignment of this?
3. How do you explicitly bind this?
4. How can you seal a specific this to a function? Why do that? Why not?
5. How do you create a new this?

Closure

Remember lexical scope?

Closure absolutely depends on it. Go review it if you're still confused. :)

Closure is when a function "remembers" its lexical scope even when the function is executed outside that lexical scope.

Closure

```
1  function foo() {
2      var bar = "bar";
3
4      function baz() {
5          console.log(bar);
6      }
7
8      bam(baz);
9  }
10
11 function bam(baz) {
12     baz();          // "bar"
13 }
14
15 foo();
```

Closure

Code Me

```
1  function foo() {
2      var bar = "bar";
3
4      return function() {
5          console.log(bar);
6      };
7  }
8
9  function bam() {
10     foo()();                    // "bar"
11 }
12
13 bam();
```

Closure

```
1 function foo() {
2     var bar = "bar";
3
4     setTimeout(function() {
5         console.log(bar);
6     },1000);
7 }
8
9 foo();
```

Closure

```
1 function foo() {
2     var bar = "bar";
3
4     $("#btn").click(function(evt) {
5         console.log(bar);
6     });
7 }
8
9 foo();
```

Closure

```
1  function foo() {
2      var bar = 0;
3
4      setTimeout(function(){
5          console.log(bar++);
6      },100);
7      setTimeout(function(){
8          console.log(bar++);
9      },200);
10 }
11
12 foo();  // 0 1
```

Closure: shared scope

Code Me

```
1  function foo() {
2      var bar = 0;
3
4      setTimeout(function(){
5          var baz = 1;
6          console.log(bar++);
7
8          setTimeout(function(){
9              console.log(bar+baz);
10         },200);
11     },100);
12 }
13
14 foo();  // 0 2
```

Closure: nested scope

```
1 for (var i=1; i<=5; i++) {
2     setTimeout(function(){
3         console.log("i: " + i);
4     },i*1000);
5 }
```

Closure: loops

Code Me

```
1 for (var i=1; i<=5; i++) {
2     (function(i){
3         setTimeout(function(){
4             console.log("i: " + i);
5         },i*1000);
6     })(i);
7 }
```

Closure: loops

Code Me

```
1 for (let i=1; i<5; i++) {
2     setTimeout(function(){
3         console.log("i: " + i);
4     },i*1000);
5 }
```

Closure: loops + block scope

```
1 var foo = (function(){
2
3     var o = { bar: "bar" };
4
5     return { obj: o };
6
7 })();
8
9 console.log(foo.obj.bar);    // "bar"
```

Closure?

```
1  var foo = (function(){
2
3      var o = { bar: "bar" };
4
5      return {
6          bar: function(){
7              console.log(o.bar);
8          }
9      };
10
11 })();
12
13 foo.bar();        // "bar"
```

Closure: classic module pattern

Code Me

```
1  var foo = (function(){
2      var publicAPI = {
3          bar: function(){
4              publicAPI.baz();
5          },
6          baz: function(){
7              console.log("baz");
8          }
9      };
10     return publicAPI;
11 })();
12
13 foo.bar();        // "baz"
```

Closure: modified module pattern

Code Me

```
1  define("foo",function(){
2
3      var o = { bar: "bar" };
4
5      return {
6          bar: function(){
7              console.log(o.bar);
8          }
9      };
10
11 });
```

Closure: modern module pattern

foo.js:

```
1 var o = { bar: "bar" };
2
3 export function bar() {
4     return o.bar;
5 }
```

```
1 import bar from "foo";
2 bar(); // "bar"
3
4 module foo from "foo";
5 foo.bar(); // "bar"
```

Closure: future/ES6+ module pattern

Quiz

1. What is a closure and how is it created?
2. How long does its scope stay around?
3. Why doesn't a function callback inside a loop behave as expected? How do we fix it?
4. How do you use a closure to create an encapsulated module? What's the benefits of that approach?

(exercise #5: 20min)

http://dmitrysoshnikov.com/ecmascript/javascript-the-core/

Agenda

Object-Orienting

- Encapsulation
- Common OO Patterns
- prototype
- "Inheritance" vs. "Behavior Delegation"
  (OO vs. OLOO)

Information hiding

Principle of Least Exposure

In OO, we “hide” private data from the external API

Encapsulation

private

~~protected~~

public

Encapsulation

```
var Hello = function(d){
    var name;   // private data!

    // auto-execute "constructor"
    (function Hello(d) {
        name = d.name;
    })(d);

    function speak() {
        console.log("Hello " + name);
    }

    var publicAPI = {
        speak: speak
    };
    return publicAPI;
};

var world = Hello({ name:"world" });
world.speak();  // "Hello world"
```

Encapsulation

Code Me

```
var Hello = function(d){
    //var name; // private data!

    // auto-execute "constructor"
    (function Hello(d) {
        this.name = d.name;
    })(d);

    function speak() {
        console.log("Hello " + this.name);
    }

    var publicAPI = {
        speak: speak
    };
    return publicAPI;
};

var world = Hello({ name:"world" });
world.speak();  // "Hello undefined"
```

Encapsulation: this'ification

```
var Hello = function(d){
    var self = this;    // remember thyself

    // auto-execute "constructor"
    (function Hello(d) {
        self.name = d.name;
    })(d);

    function speak() {
        console.log("Hello " + self.name);
    }

    var publicAPI = {
        speak: speak
    };
    return publicAPI;
};

var world = Hello({ name:"world" });
world.speak();  // "Hello world"
```

Encapsulation: this'ification

```
var Hello = function(d){
    var self = this;    // remember thyself

    // auto-execute "constructor"
    (function Hello(d) {
        self.name = d.name;
    })(d);

    function speak() {
        console.log("Hello " + self.name);
    }

    var publicAPI = {
        speak: speak
    };
    return publicAPI;
};

var world = new Hello({ name:"world" });
world.speak();  // "Hello world"
```

Encapsulation: this'ification

OO Design Patterns

Singleton

```
1  var Router = function() {
2      // Singleton!
3      if (Router.__instance__) {
4          return Router.__instance__;
5      }
6
7      Router.__instance__ = this;
8      this.routes = {};
9  };
10
11 Router.prototype.setRoute = function(match,fn) {
12     this.routes[match] = fn;
13 };
14
15 var myrouter = new Router();
16 var another = new Router();
17
18 myrouter === another;
```

OO Design Patterns: singleton

```
1  var Router = function() {
2      // Singleton!
3      if (Router.__instance__) {
4          return Router.__instance__;
5      }
6
7      function setRoute(match,fn) {
8          routes[match] = fn;
9      }
10
11     var routes = {};
12     var publicAPI = Router.__instance__ = {
13         setRoute: setRoute
14     };
15     return publicAPI;
16 };
17
18
19 var myrouter = new Router();
20 var another = new Router();
21
22 myrouter === another;
```

OO Design Patterns: singleton

Observer

```
1  function PageController(router) {
2      this.router = router;
3      this.router.on("navigate",
4          this.fetchPage.bind(this)
5      );
6  }
7  PageController.prototype.fetchPage = function(d) {
8      $.ajax({
9          url: d.page_url
10     })
11     .done(this.loaded.bind(this,d.page_url));
12 };
13 PageController.prototype.loaded = function(d,u) {
14     // display the page content from `d`
15     // ...
16     this.router.emit("pageLoaded",u);
17 };
18
19 var router = new Router();
20 var thepage = new PageController(router);
```

OO Design Patterns: observer

prototype

Every single “object” is built by a constructor function

prototype

Each time a constructor is called, a new object is created

prototype

A constructor makes an object "~~based on~~" its own prototype

A constructor makes an object linked to its own prototype

```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  var a1 = new Foo("a1");
9  var a2 = new Foo("a2");
10
11 a2.speak = function() {
12     alert("Hello, " + this.identify() + ".");
13 };
14
15 a1.constructor === Foo;
16 a1.constructor === a2.constructor;
17 a1.__proto__ === Foo.prototype;
18 a1.__proto__ === a2.__proto__;
```

prototype

Code Me

```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  var a1 = new Foo("a1");
9  var a2 = new Foo("a2");
10
11 a2.speak = function() {
12     alert("Hello, " + this.identify() + ".");
13 };
14
15 a1.__proto__ === Object.getPrototypeOf(a1);
16 a2.constructor === Foo;
17 a1.__proto__ == a2.__proto__;
18 a2.__proto__ == a2.constructor.prototype;
```

prototype

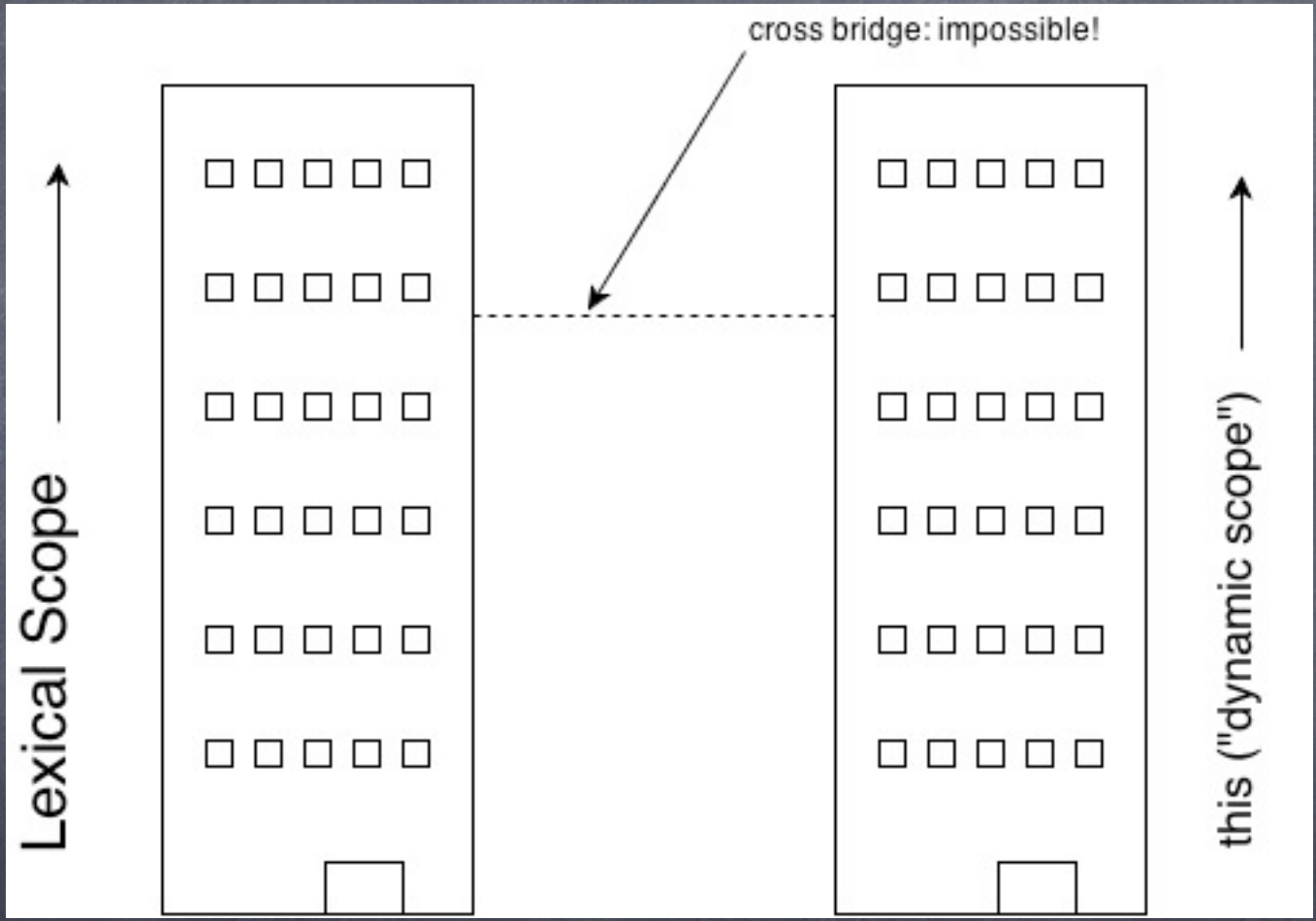
```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  var a1 = new Foo("a1");
9  a1.identify();  // "I am a1"
10
11 a1.identify = function() {  // <-- Shadowing
12     alert("Hello, " +
13         Foo.prototype.identify.call(this) +
14     ".");
15 };
16
17 a1.identify();  // alerts: "Hello, I am a1."
```

Code Me

prototype

```
1  function Foo(who) {
2      this.me = who;
3  }
4
5  Foo.prototype.identify = function() {
6      return "I am " + this.me;
7  };
8
9  Foo.prototype.speak = function() {
10     alert("Hello, " +
11         this.identify() + // super unicorn magic
12     ".");
13 };
14
15 var a1 = new Foo("a1");
16 a1.speak(); // alerts: "Hello, I am a1."
```

prototype

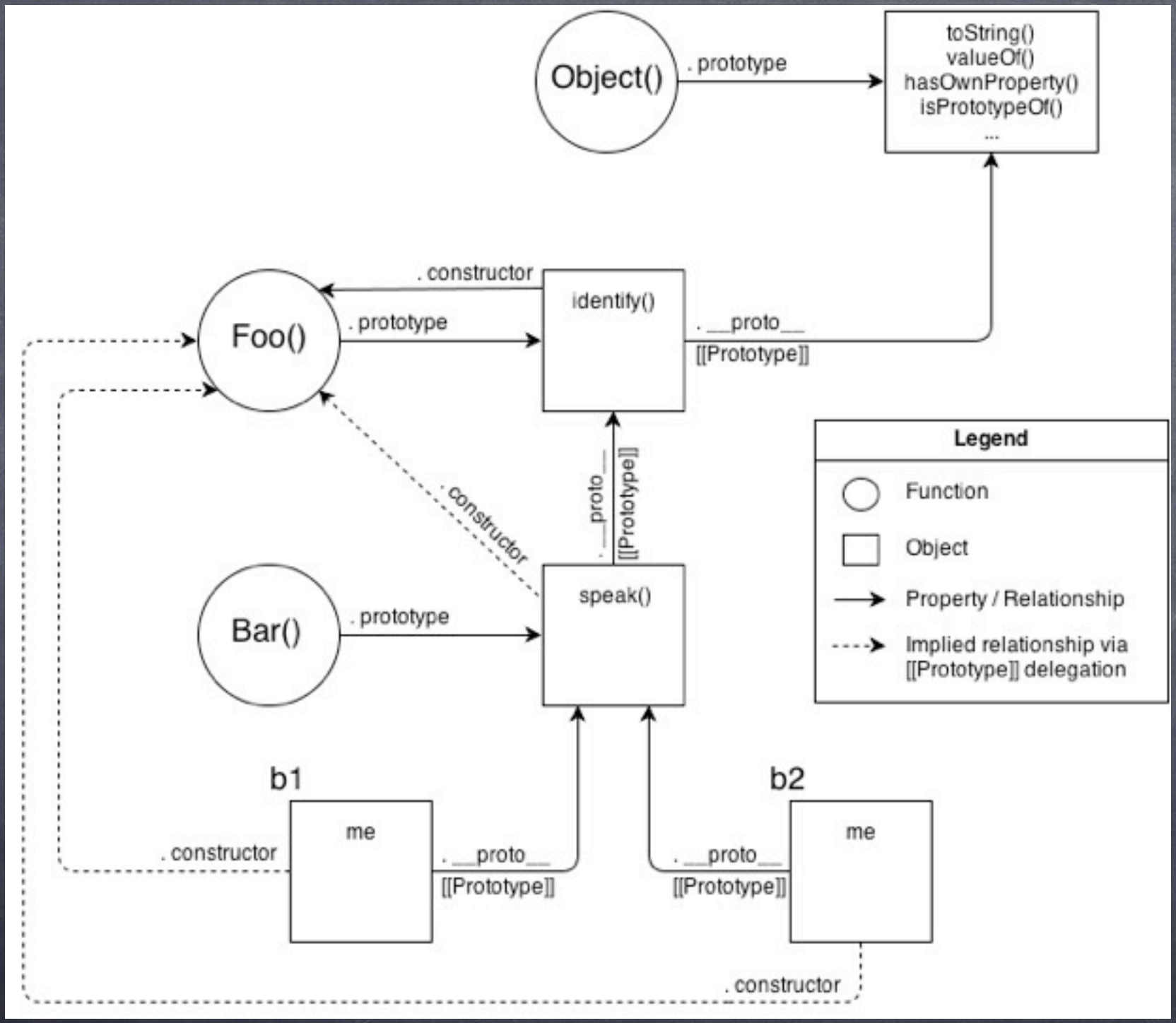


prototype

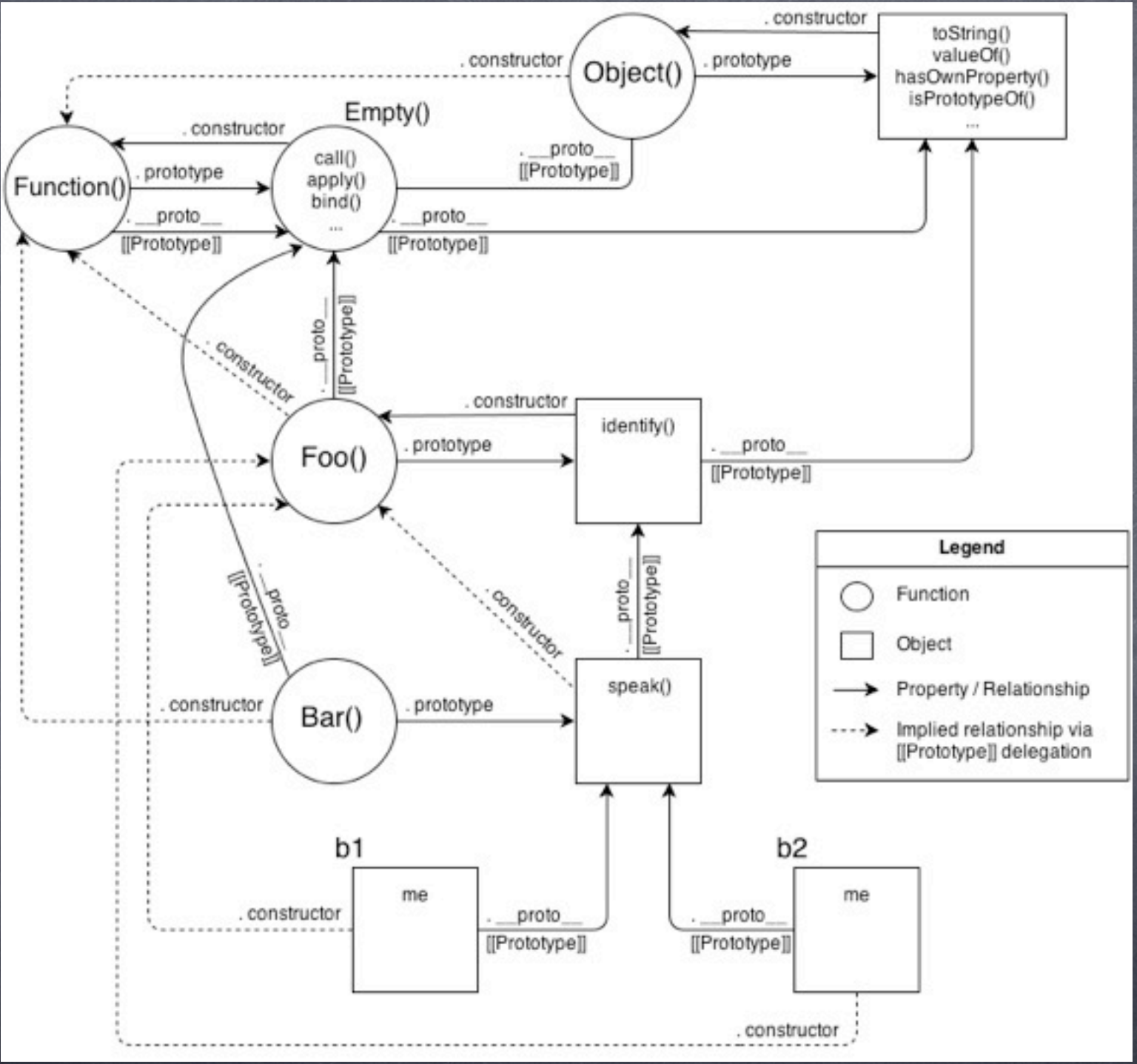
```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  function Bar(who) {
9      Foo.call(this,who);
10 }
11 // Bar.prototype = new Foo();    // Or...
12 Bar.prototype = Object.create(Foo.prototype);
13 // NOTE: constructor is borked here, need to fix
14
15 Bar.prototype.speak = function() {
16     alert("Hello, " + this.identify() + ".");
17 };
18
19 var b1 = new Bar("b1");
20 var b2 = new Bar("b2");
21
22 b1.speak(); // alerts: "Hello, I am b1."
23 b2.speak(); // alerts: "Hello, I am b2."
```

prototype: objects linked

Code Me



prototype: objects linked



prototype: objects linked

Quiz

1. What is a constructor?
2. What is a [[Prototype]] and where does it come from?
3. How does a [[Prototype]] affect an object?
4. How do we find out where an object's [[Prototype]] points to (3 ways)?

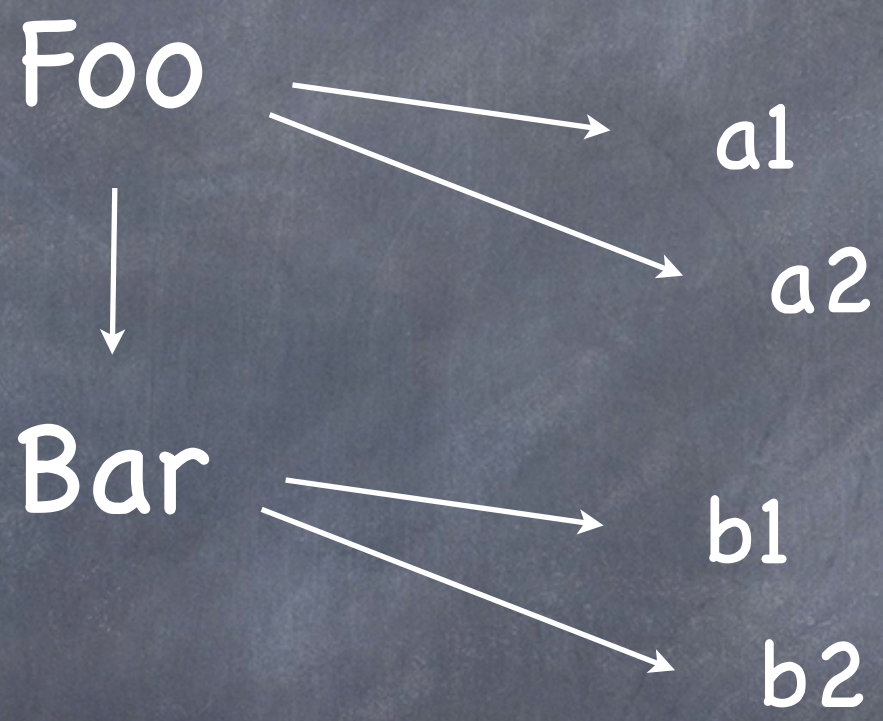
remember how this has a pesky way of getting unassigned?

```
1  function Foo(who) {
2      this.me = who;
3  }
4
5  Foo.prototype.speak = function() {
6      alert("Hello, I am " + this.me + ".");
7  };
8
9  var a1 = new Foo("a1");
10
11 $("#speak").click(a1.speak);
```

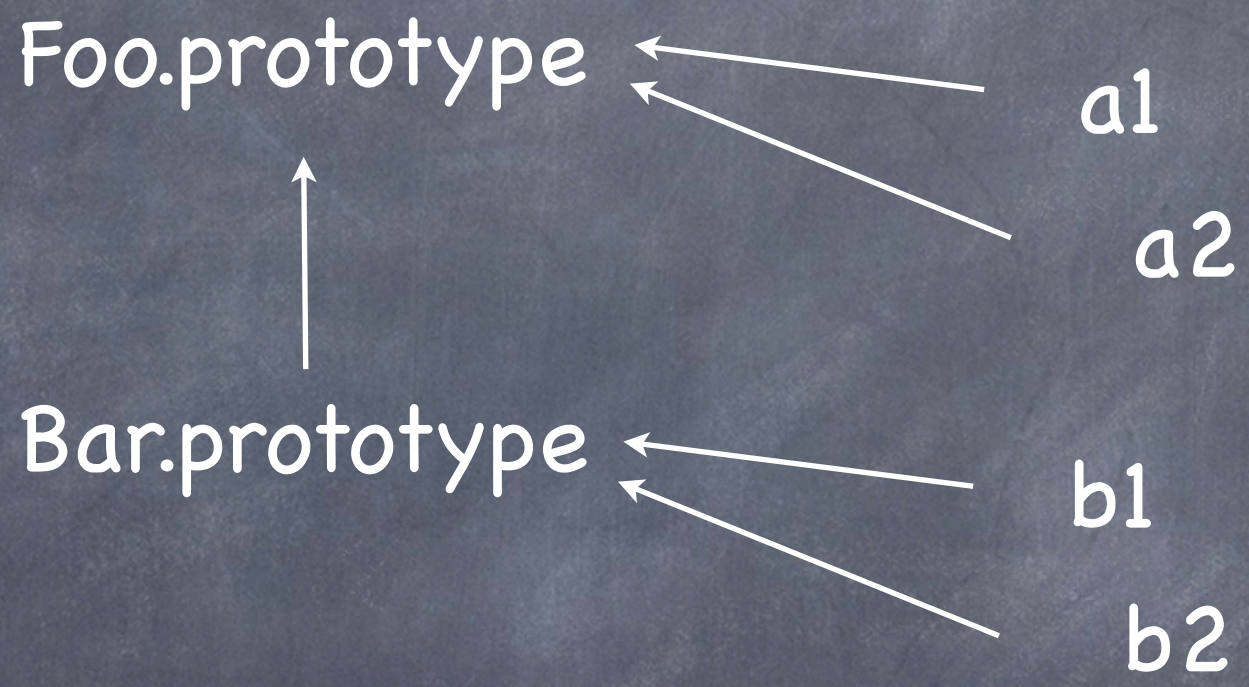
prototype: this redux

(exercise #7: 20min)

Inheritance



OO: classical inheritance



(another design pattern)

OO: “prototypal inheritance”

JS ~~"Inheritance"~~
"Behavior Delegation"

```
1  function Foo(who) {
2      this.me = who;
3  }
4
5  Foo.prototype.speak = function() {
6      alert("Hello, I am " + this.me + ".");
7  };
8
9  var a1 = new Foo("a1");
10
11 a1.speak(); // alerts: "Hello, I am a1."
```

OO: ~~inheritance~~ delegation

Let's simplify!

OLOO:

Objects Linked to Other Objects

```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  function Bar(who) {
9      Foo.call(this,who);
10 }
11 Bar.prototype = Object.create(Foo.prototype);
12
13 Bar.prototype.speak = function() {
14     alert("Hello, " + this.identify() + ".");
15 };
16
17 var b1 = new Bar("b1");
18 b1.speak(); // alerts: "Hello, I am b1."
```

OLOO: delegated objects

Code Me

```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  function Bar(who) {
9      Foo.call(this,who);
10 }
11 Bar.prototype = Object.create(Foo.prototype);
12
13 Bar.prototype.speak = function() {
14     alert("Hello, " + this.identify() + ".");
15 };
16
17 var b1 = Object.create(Bar.prototype);
18 Bar.call(b1,"b1");
19 b1.speak();
```

OLOO: delegated objects

```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  var Bar = Object.create(Foo.prototype);
9  Bar.init = function(who) {
10     Foo.call(this,who);
11 };
12 Bar.speak = function() {
13     alert("Hello, " + this.identify() + ".");
14 };
15
16 var b1 = Object.create(Bar);
17 b1.init("b1");
18 b1.speak(); // alerts: "Hello, I am b1."
```

OLOO: delegated objects

Code Me

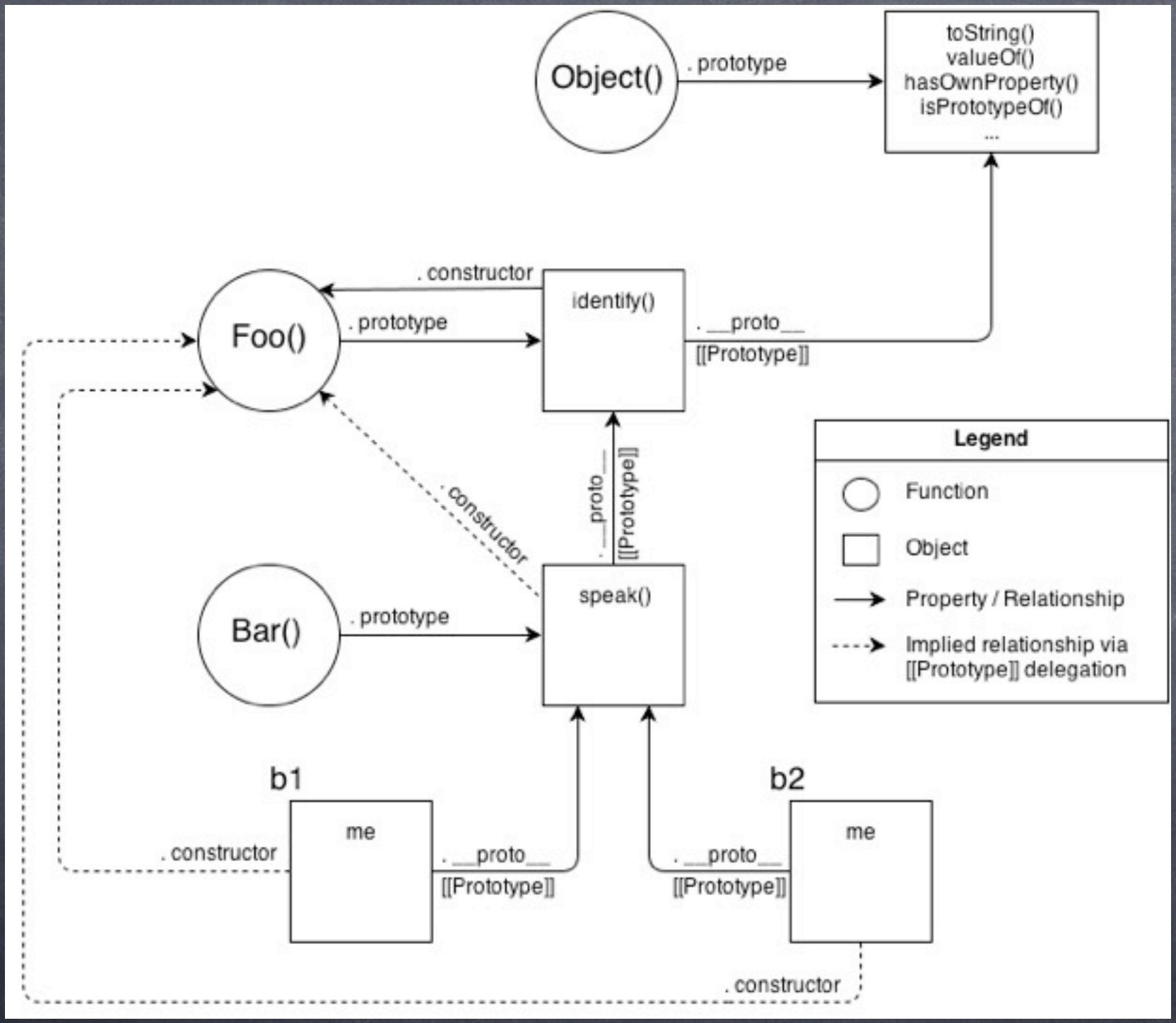
```
1  var Foo = {
2      init: function(who) {
3          this.me = who;
4      },
5      identify: function() {
6          return "I am " + this.me;
7      }
8  };
9
10 var Bar = Object.create(Foo);
11
12 Bar.speak = function() {
13     alert("Hello, " + this.identify() + ".");
14 };
15
16 var b1 = Object.create(Bar);
17 b1.init("b1");
18 b1.speak(); // alerts: "Hello, I am b1."
```

OLOO: delegated objects

Code Me

```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  function Bar(who) {
9      Foo.call(this,who);
10 }
11 // Bar.prototype = new Foo();   // Or...
12 Bar.prototype = Object.create(Foo.prototype);
13 // NOTE: .constructor is borked here, need to fix
14
15 Bar.prototype.speak = function() {
16     alert("Hello, " + this.identify() + ".");
17 };
18
19 var b1 = new Bar("b1");
20 var b2 = new Bar("b2");
21
22 b1.speak(); // alerts: "Hello, I am b1."
23 b2.speak(); // alerts: "Hello, I am b2."
```

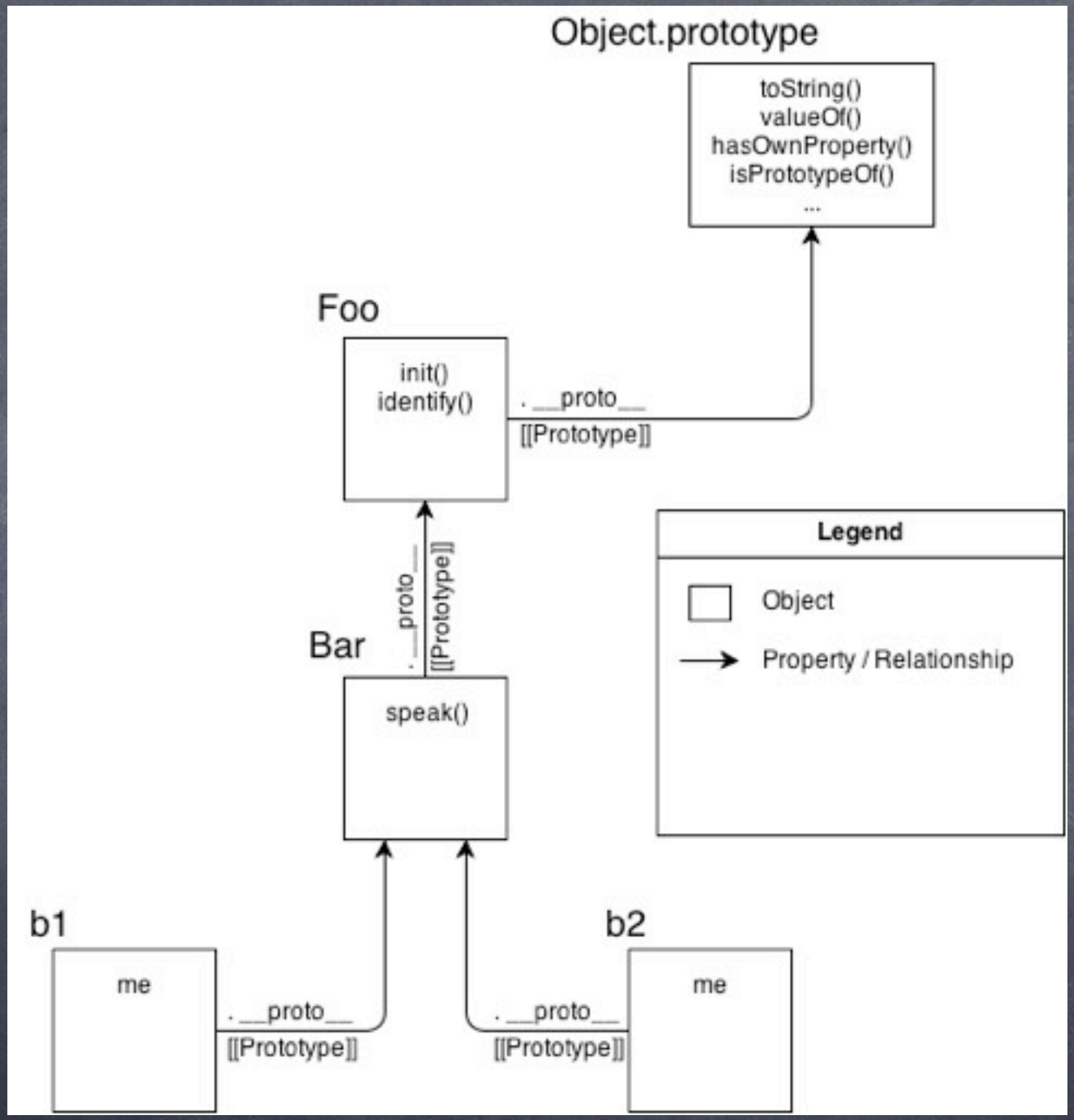
OO: old & busted



OO: old & busted

```
var Foo = {
    init: function(who) {
        this.me = who;
    },
    identify: function() {
        return "I am " + this.me;
    }
};

var Bar = Object.create(Foo);

Bar.speak = function() {
    alert("Hello, " + this.identify() + ".");
};

var b1 = Object.create(Bar);
b1.init("b1");
var b2 = Object.create(Bar);
b2.init("b2");

b1.speak(); // alerts: "Hello, I am b1."
b2.speak(); // alerts: "Hello, I am b2."
```

OLOO: new hotness



OLOO: new hotness

```
1 if (!Object.create) {
2     Object.create = function (o) {
3         function F() {}
4         F.prototype = o;
5         return new F();
6     };
7 }
```

OLOO: Object.create()

https://gist.github.com/getify/5572383

https://gist.github.com/getify/5226305

OLOO: object creation

```
1  var Foo = {
2      init: function(who) {
3          this.me = who;
4      },
5      identify: function() {
6          return "I am " + this.me;
7      }
8  };
9
10 var Bar = Object.create(Foo);
11 Bar.init = function(who) {
12     this.__proto__.init(who); // Uh oh!
13 };
14 Bar.speak = function() {
15     alert("Hello, " + this.identify() + ".");
16 };
17
18 var b1 = Object.create(Bar);
19 b1.init("b1");
20 b1.speak(); // alerts: "Hello, I am b1."
```

OLOO: relative polymorphism?

```
var Foo = {
    init: function(who) {
        this.me = who;
    },
    identify: function() {
        return "I am " + this.me;
    }
};

var Bar = Object.create(Foo);
Bar.init = function(who) {
    Foo.init.call(this,who); // Ugly
};
Bar.speak = function() {
    alert("Hello, " + this.identify() + ".");
};

var b1 = Object.create(Bar);
b1.init("b1");
b1.speak(); // alerts: "Hello, I am b1."
```

OLOO: ~~relative polymorphism~~ mixins! :(

https://gist.github.com/getify/5297595

OLOO: relative polymorphism...sorta

Quiz

1. How is JavaScript's [[Prototype]] chain not like traditional/classical inheritance?
2. What does "behavior delegation" mean and how does it describe object linking in JS?
3. Why is "behavior delegation" as a design pattern a helpful thing? What are the tradeoffs?

(exercise #8: 10min)

Agenda

Async Patterns

- Callbacks
- Generators/Coroutines
- Promises

Callbacks

```
1 setTimeout(function(){
2     console.log("callback!");
3 },1000);
```

Async Patterns: callbacks

```
1 setTimeout(function(){
2     console.log("one");
3     setTimeout(function(){
4         console.log("two");
5         setTimeout(function(){
6             console.log("three");
7         },1000);
8     },1000);
9 },1000);
```

Async Patterns: “callback hell”

```
1  function one(cb) {
2      console.log("one");
3      setTimeout(cb,1000);
4  }
5  function two(cb) {
6      console.log("two");
7      setTimeout(cb,1000);
8  }
9  function three() {
10     console.log("three");
11 }
12
13 one(function(){
14     two(three);
15 });
```

Async Patterns: “callback hell”

Inversion of Control

```
1  function trySomething(ok,err) {
2      setTimeout(function(){
3          var num = Math.random();
4          if (num > 0.5) ok(num);
5          else err(num);
6      },1000);
7  }
8
9  trySomething(
10     function(num){
11         console.log("Success: " + num);
12     },
13     function(num){
14         console.log("Sorry: " + num);
15     }
16 );
```

Async Patterns: separate callbacks

```
1  function trySomething(cb) {
2      setTimeout(function(){
3          var num = Math.random();
4          if (num > 0.5) cb(null,num);
5          else cb("Too low!");
6      },1000);
7  }
8
9  trySomething(function(err,num){
10     if (err) {
11         console.log(err);
12     }
13     else {
14         console.log("Number: " + num)
15     }
16 });
```

Async Patterns: “error-first style”

```
1  function getData(d,cb) {
2      setTimeout(function(){ cb(d); },1000);
3  }
4
5  getData(10,function(num1){
6      var x = 1 + num1;
7      getData(30,function(num2){
8          var y = 1 + num2;
9          getData(
10             "Meaning of life: " + (x + y),
11             function(answer){
12                 console.log(answer);
13                 // Meaning of life: 42
14             }
15         );
16     });
17 });
```

Async Patterns: nested-callback tasks

Code Me

Generators (yield)

```
1 function* gen() {
2     console.log("Hello");
3     yield null;
4     console.log("World");
5 }
6
7 var it = gen();
8 it.next(); // prints "Hello"
9 it.next(); // prints "World"
```

Async Patterns: generators

```
1 function coroutine(g) {
2     var it = g();
3     return function(){
4         return it.next.apply(it,arguments);
5     };
6 }
```

Async Patterns: generator coroutines

```
1  var run = coroutine(function*(){
2      var x = 1 + (yield null);
3      var y = 1 + (yield null);
4      yield (x + y);
5  });
6
7  run();
8  run(10);
9  console.log(
10     "Meaning of life: " + run(30).value
11 );
```

Async Patterns: generator messages

```
1  function getData(d) {
2      setTimeout(function(){ run(d); },1000);
3  }
4
5  var run = coroutine(function*(){
6      var x = 1 + (yield getData(10));
7      var y = 1 + (yield getData(30));
8      var answer = (yield getData(
9          "Meaning of life: " + (x + y)
10     ));
11     console.log(answer);
12     // Meaning of life: 42
13 });
14
15 run();
```

Async Patterns: yield tasks

Promises

“continuation events”

```
1  var wait = jQuery.Deferred();
2  var p = wait.promise();
3
4  p.done(function(value){
5      console.log(value);
6  });
7
8  setTimeout(function(){
9      wait.resolve(Math.random());
10 },1000);
```

Async Patterns: jQuery-style promises

```
1  function waitForN(n) {
2      var d = $.Deferred();
3      setTimeout(d.resolve,n);
4      return d.promise();
5  }
6
7  waitForN(1000)
8  .then(function(){
9      console.log("Hello world");
10     return waitForN(2000);
11 })
12 .then(function(){
13     console.log("finally!")
14 });
```

Async Patterns: jQuery-style promises

```
1  function getData(d) {
2      return new Promise(function(resolve,reject){
3          setTimeout(function(){ resolve(d); },1000);
4      });
5  }
6
7  var x;
8
9  getData(10)
10 .then(function(num1){
11     x = 1 + num1;
12     return getData(30);
13 })
14 .then(function(num2){
15     var y = 1 + num2;
16     return getData("Meaning of life: " + (x + y));
17 })
18 .then(function(answer){
19     console.log(answer);
20     // Meaning of life: 42
21 });
```

Async Patterns: (native) promise tasks

Code Me

sequence = automatically chained promises

Async Patterns: promises sequence

https://github.com/getify/asynquence

```
ASQ()
.then(function(done){
    setTimeout(done,1000);
})
.gate(
    function(done){
        setTimeout(done,1000);
    },
    function(){
        setTimeout(done,1000);
    }
)
.then(function(){
    console.log("2 seconds passed!");
});
```

Async Patterns: sequences & gates

```
1  function getData(d) {
2      return ASQ(function(done){
3          setTimeout(function(){ done(d); },1000);
4      });
5  }
6
7  ASQ()
8  .waterfall(
9      function(done){ getData(10).pipe(done); },
10     function(done){ getData(30).pipe(done); }
11 )
12 .seq(function(num1,num2){
13     var x = 1 + num1;
14     var y = 1 + num2;
15     return getData("Meaning of life: " + (x + y));
16 })
17 .val(function(answer){
18     console.log(answer);
19     // Meaning of life: 42
20 });
```

Async Patterns: sequence tasks

Code Me

```
1  function getData(d) {
2      return ASQ(function(done){
3          setTimeout(function(){ done(d); },1000);
4      });
5  }
6
7  ASQ()
8  .runner(function*(){
9      var x = 1 + (yield getData(10));
10     var y = 1 + (yield getData(30));
11     var answer = yield (getData(
12         "Meaning of life: " + (x + y)
13     ));
14     return answer;
15 })
16 .val(function(answer){
17     console.log(answer);
18     // Meaning of life: 42
19 });
```

Async Patterns: generator+sequence tasks

Code Me

Quiz

1. What is "callback hell"? Why do callbacks suffer from "inversion of control"?
2. How do you pause a generator? How do you resume it?
3. What is a Promise? How does it solve inversion of control issues?
4. How do we combine generators and promises for flow control?

Take a deep breath

Kyle Simpson
@getify
http://getify.me

Thanks!

Questions?