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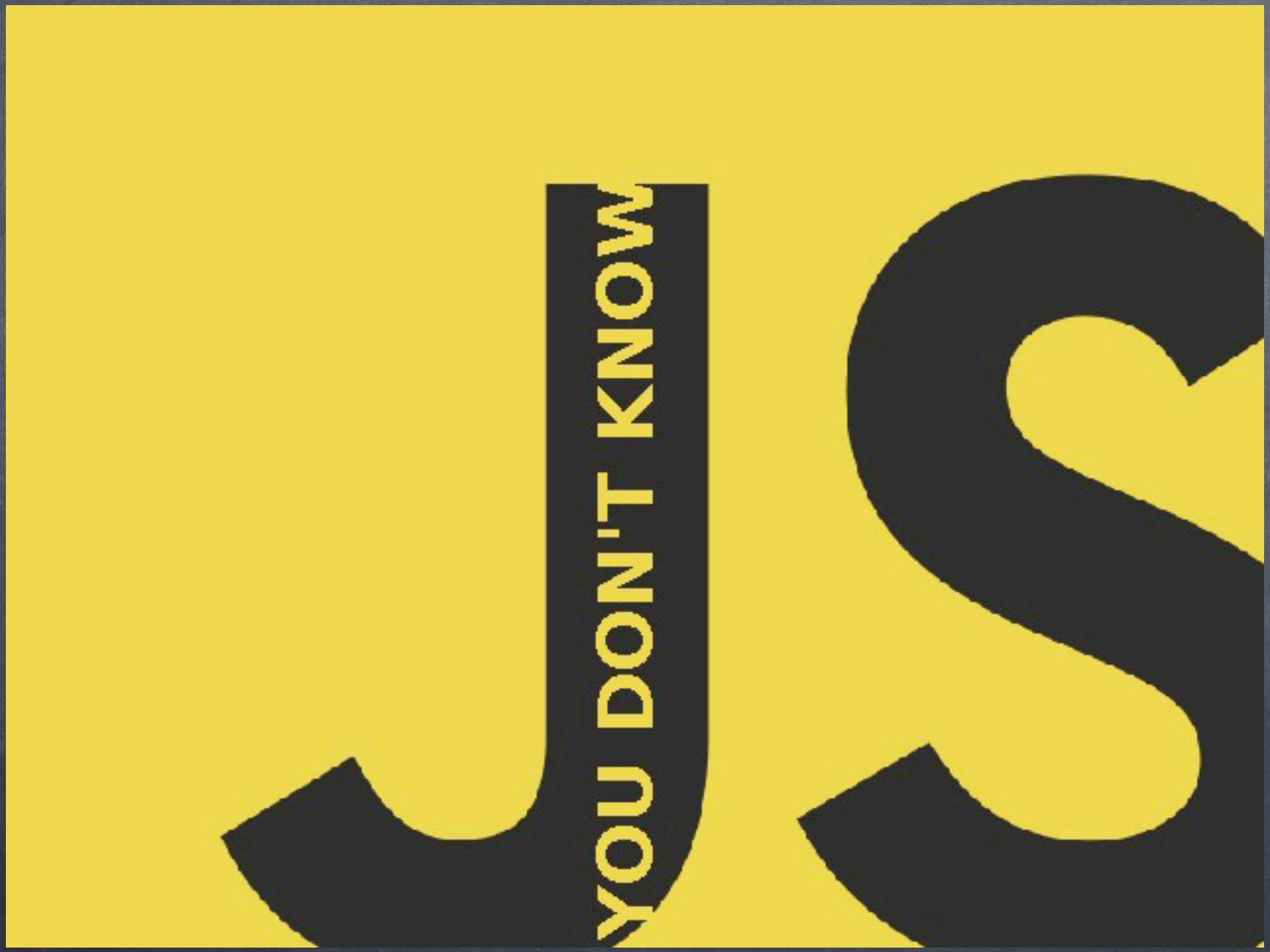
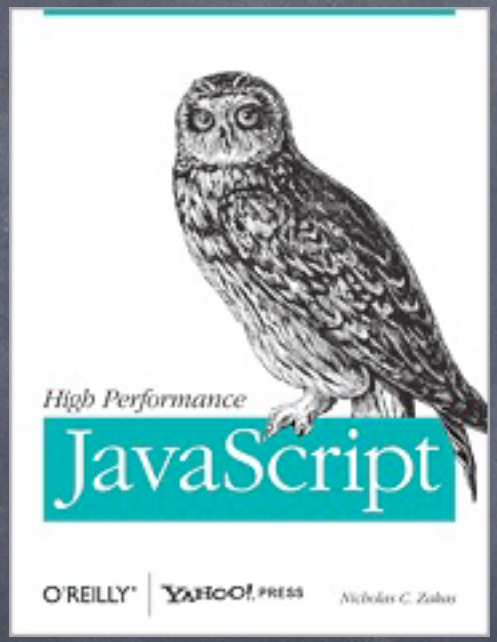


http://YouDontKnowJS.com


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 good style guide

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

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();        // ???
```


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!
```

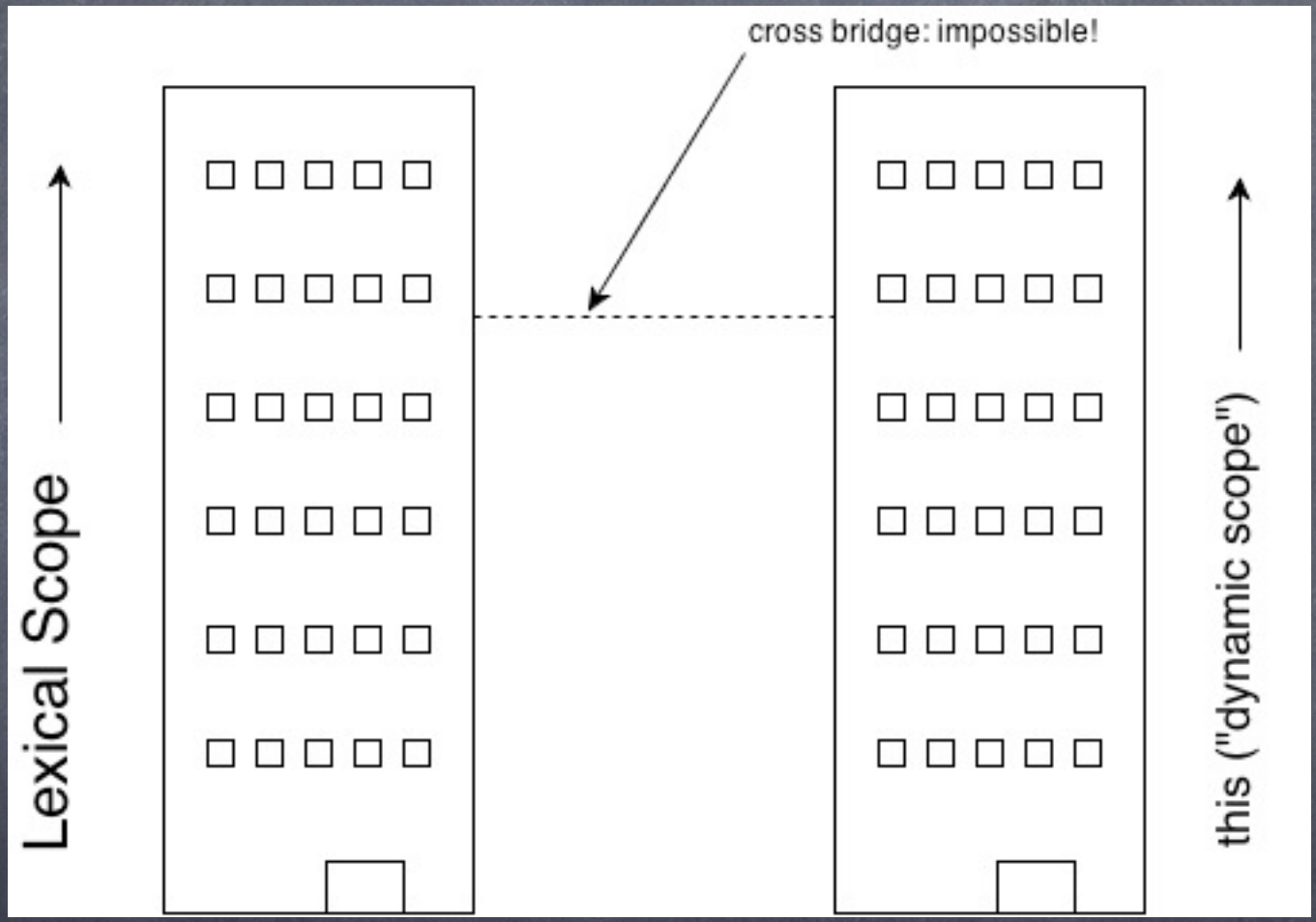
Scope: function scope?

```
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
```

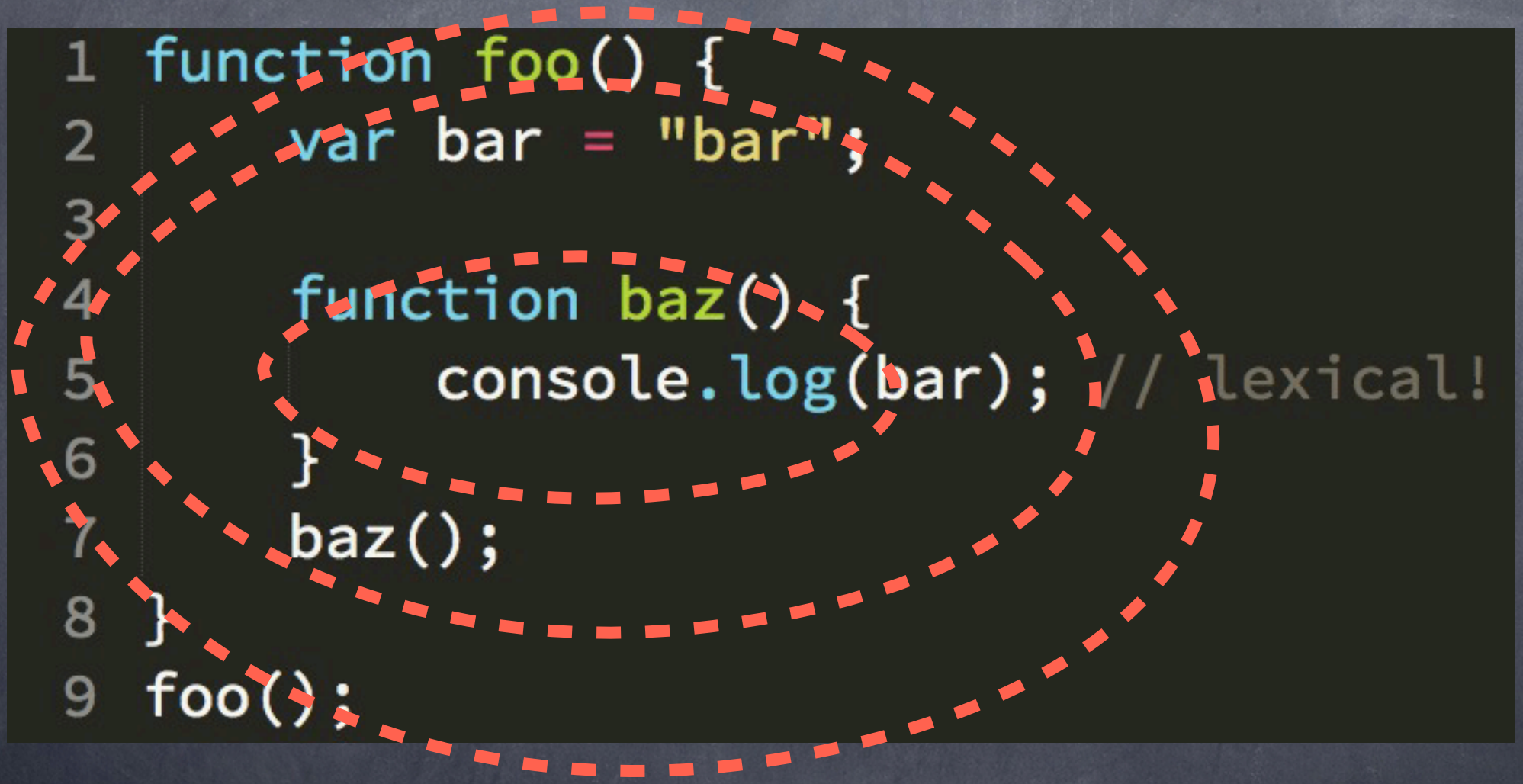
Scope: block scope?

lexical scope

dynamic scope



Scope



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 obj = {
2      a: 2,
3      b: 3,
4      c: 4
5  };
6
7  obj.a = obj.b + obj.c;
8  obj.c = obj.b - obj.a;
9
10 with (obj) {
11     a = b + c;
12     d = b - a;
13     d = 3; // ??
14 }
15
16 obj.d; // undefined
17 d; // 3 -- oops!
```

Scope: WAT!?

IIFE

```
1  var foo = "foo";
2
3  (function(){
4
5      var foo = "foo2";
6      console.log(foo);    // "foo2"
7
8  })();
9
10 console.log(foo);    // "foo"
```

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

Function Scope

```
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

```
let (foo) {
    foo = "foo";
    console.log(foo); // "foo"
}

foo; // ReferenceError
```

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

Block Scope: let

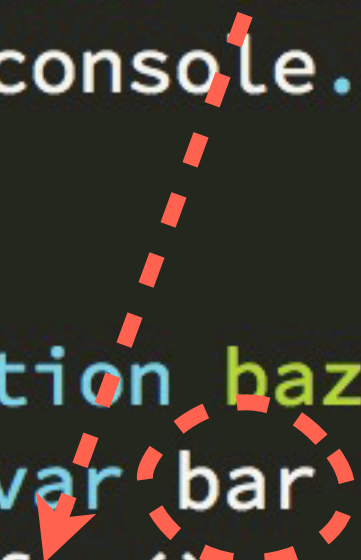
```
1 try{throw void 0}catch
2 /*let*/(foo) {
3     foo = "foo";
4     console.log(foo);
5 }
6
7 foo; // Reference Error!
```

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

Block Scope: let

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!?!?

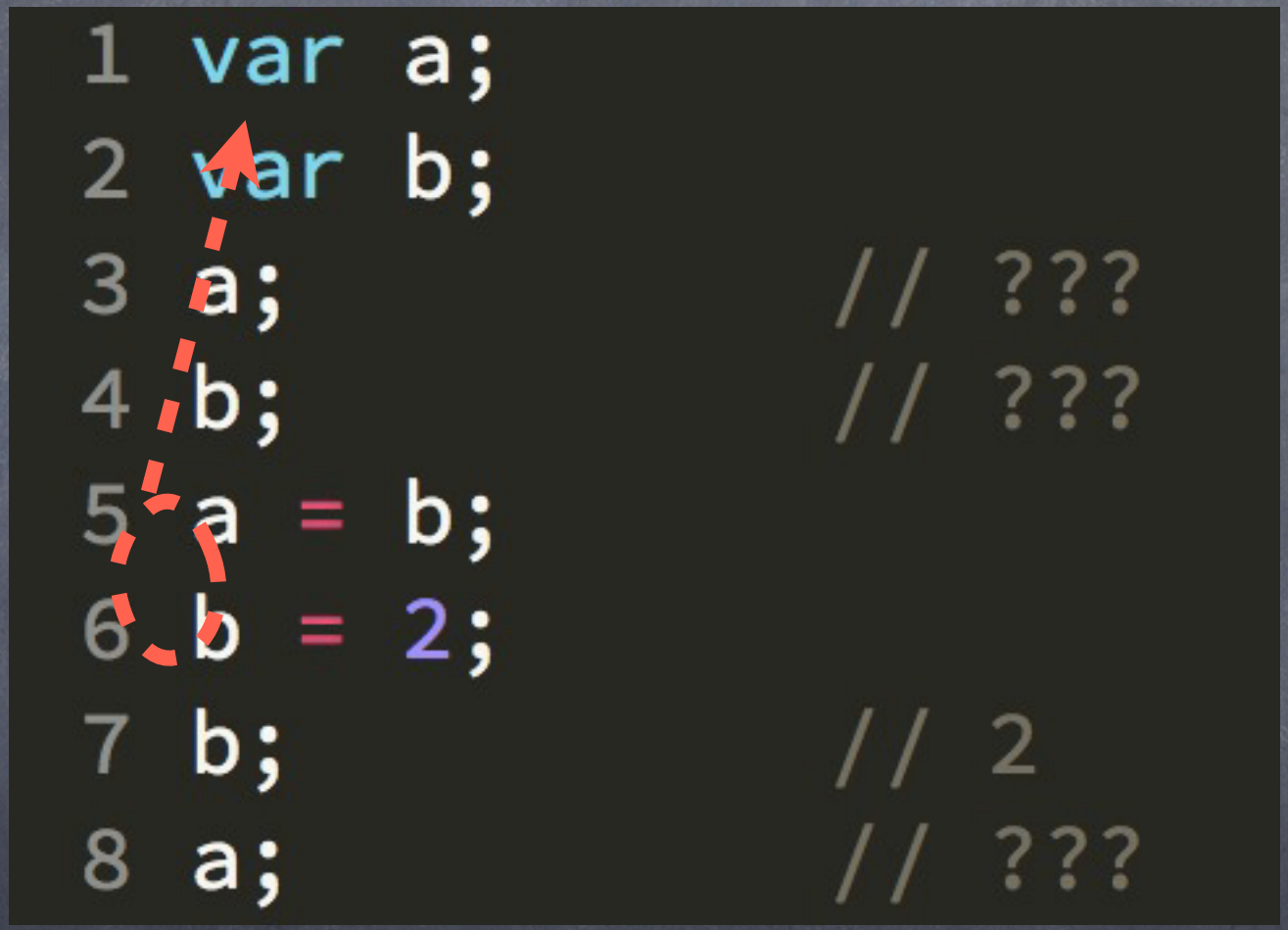
Quiz

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



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

```
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

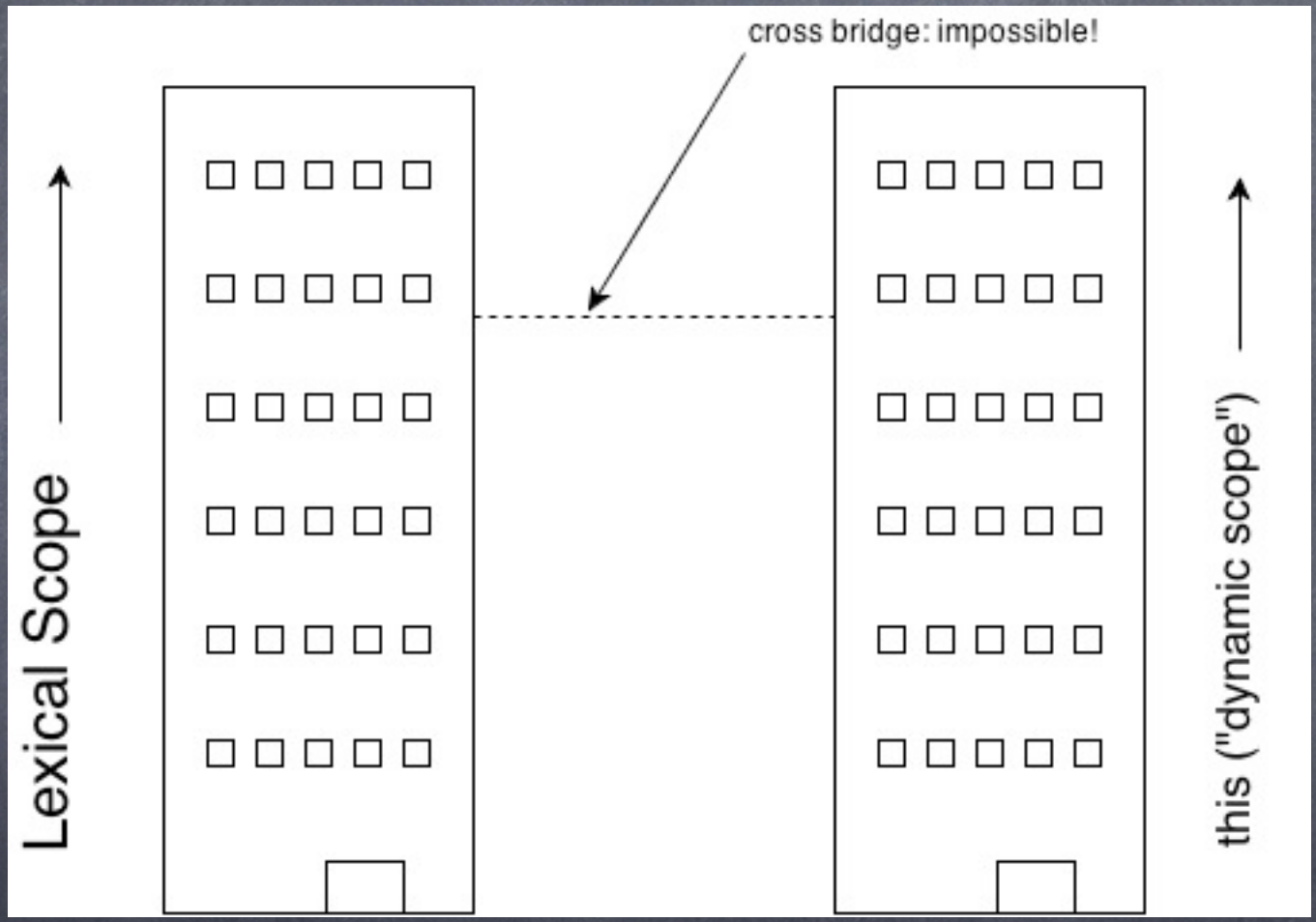
(exercise #1: 10min)

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

```
 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

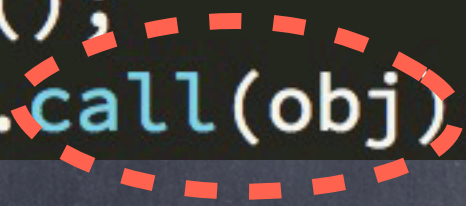
```
1  function foo() {
2      var bar = "bar1";
3      baz();
4  }
5  function baz() {
6      console.log(this.bar);
7  }
8
9  var bar = "bar2";
10 foo();                  // ???
```

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

```
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

```
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

```
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

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

```
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

```
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.

```
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();
```

```
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

```
function foo() {
    var bar = 0;

    setTimeout(function(){
        console.log(bar++);
    },100);
    setTimeout(function(){
        console.log(bar++);
    },200);
}

foo();  // 0 1
```

Closure: shared scope

```
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

```
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 }
```

Code Me

Closure: loops

```
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

```
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

```
define("foo",function(){

    var o = { bar: "bar" };

    return {
        bar: function(){
            console.log(o.bar);
        }
    };

});
```

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 #2: 20min)

Agenda

Object-Orienting

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

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

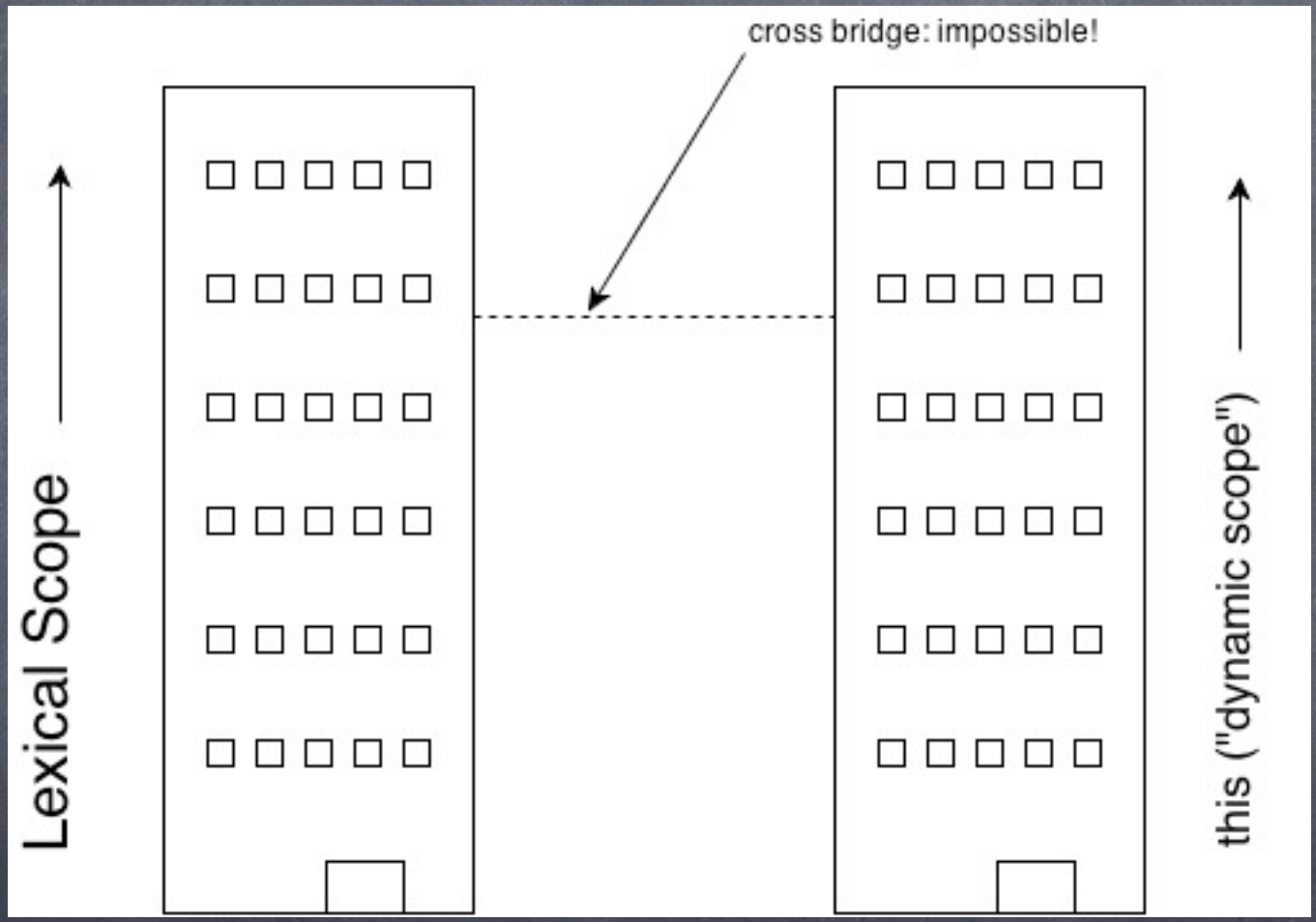
```
1  function Foo(who) {
2      this.me = who;
3  }
4  Foo.prototype.identify = function() {
5      return "I am " + this.me;
6  };
7
8  var a1 = new Foo("a1");
9  var a2 = new Foo("a2");
10
11 a2.speak = function() {
12     alert("Hello, " + this.identify() + ".");
13 };
14
15 a1.__proto__ === Object.getPrototypeOf(a1);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

```
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."
```

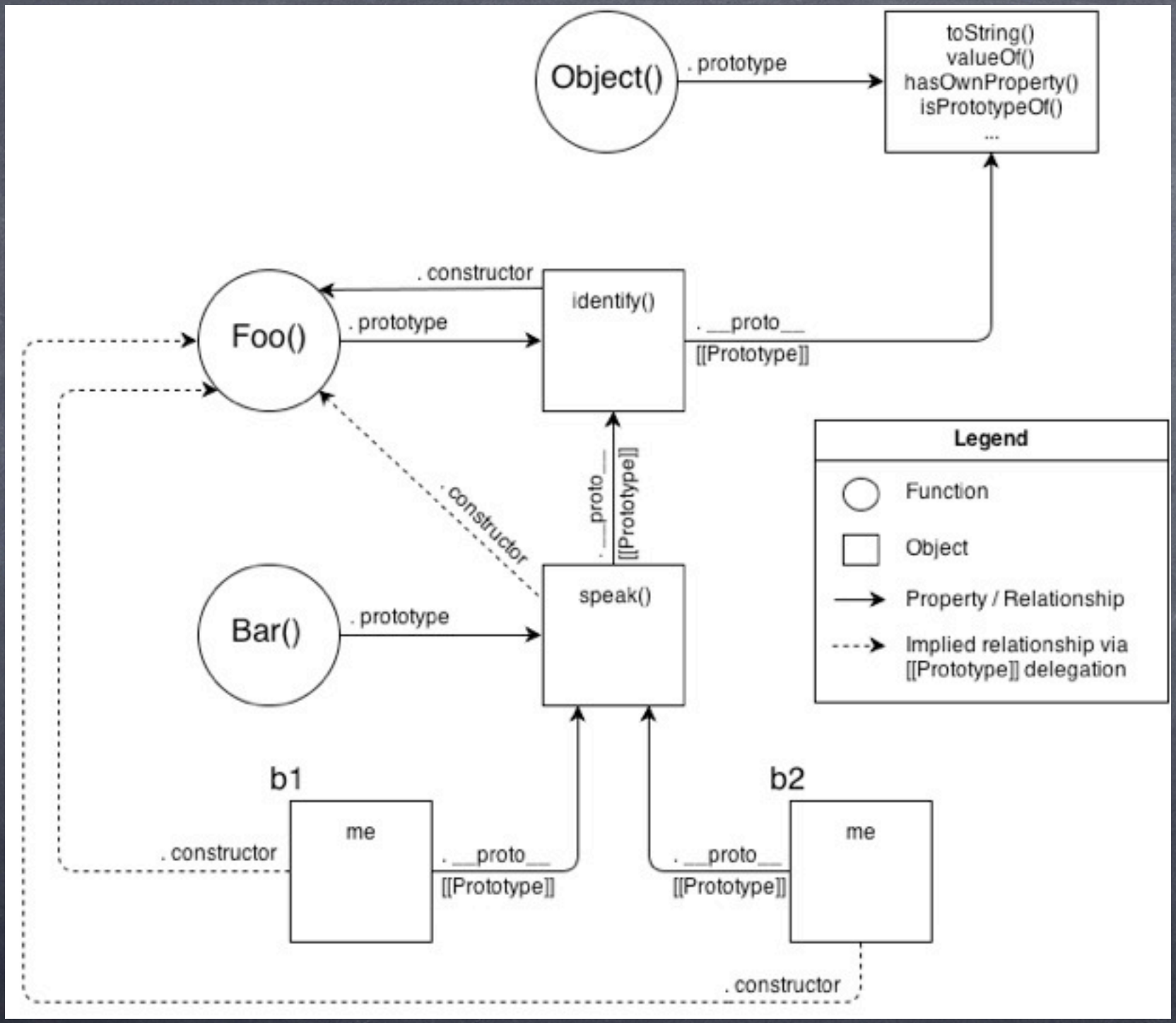
prototype



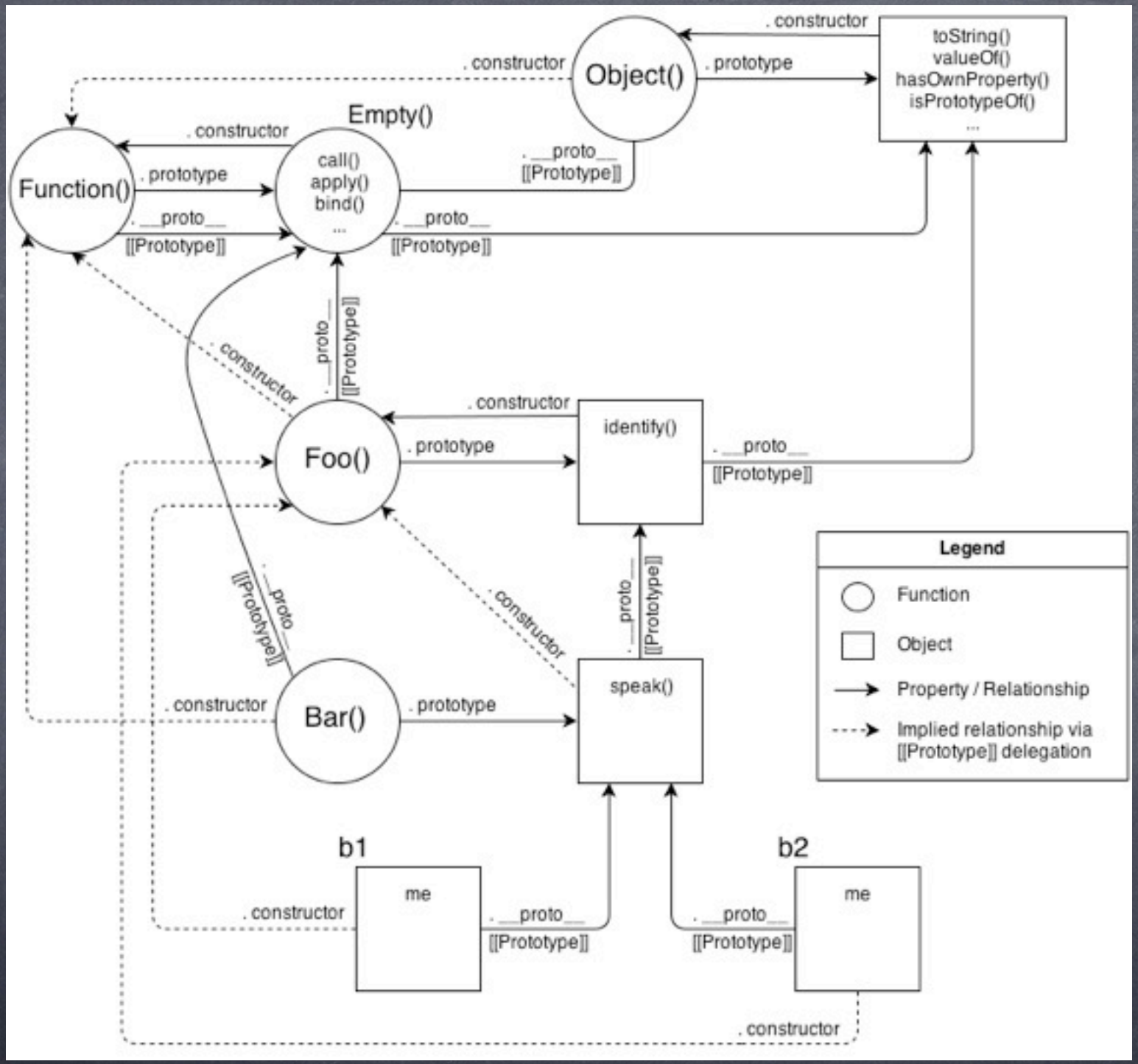
Scope

```
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



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?

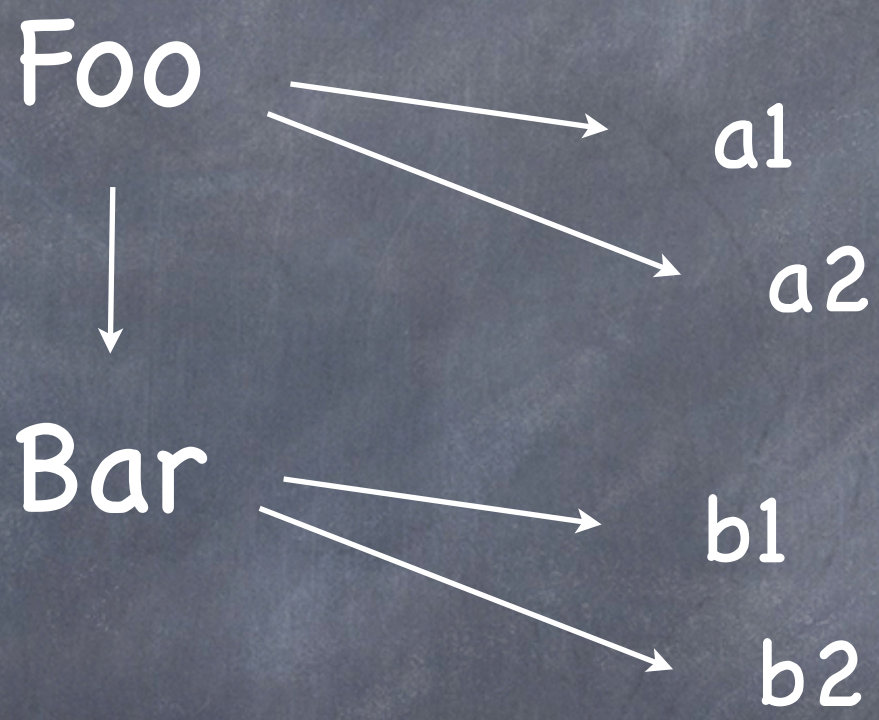
prototype: this redux

```
 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);
```

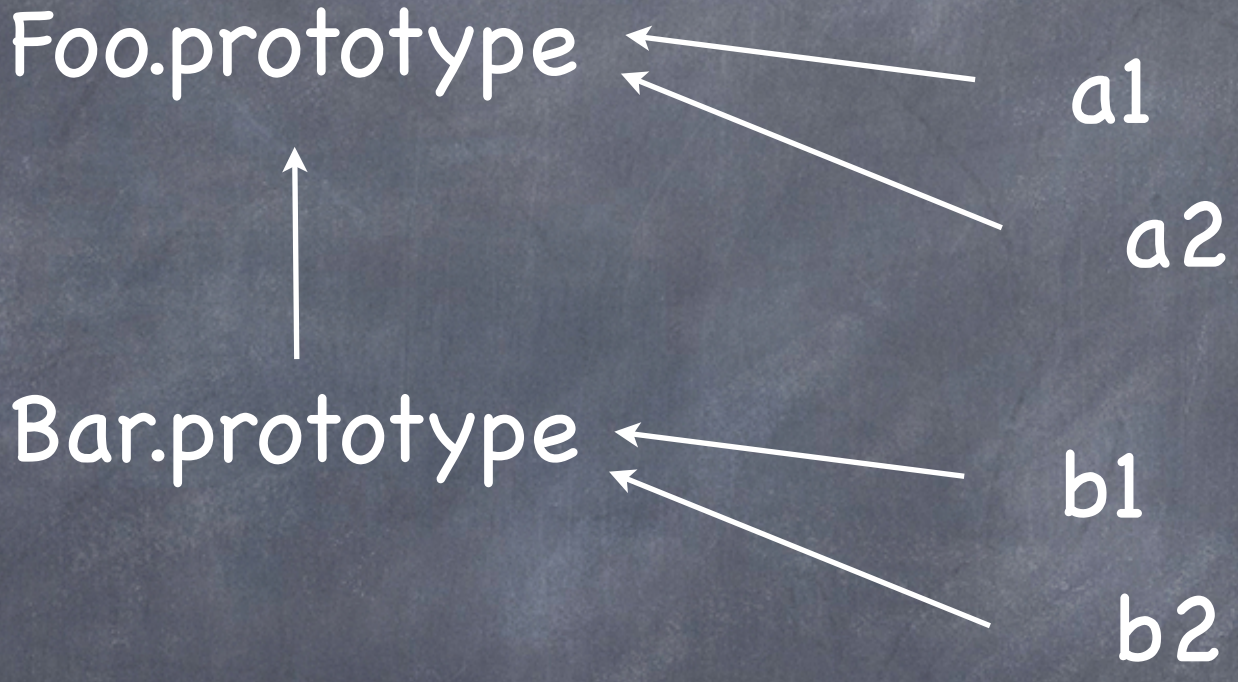
prototype: this redux

(exercise #3: 10min)

Inheritance



OO: classical inheritance

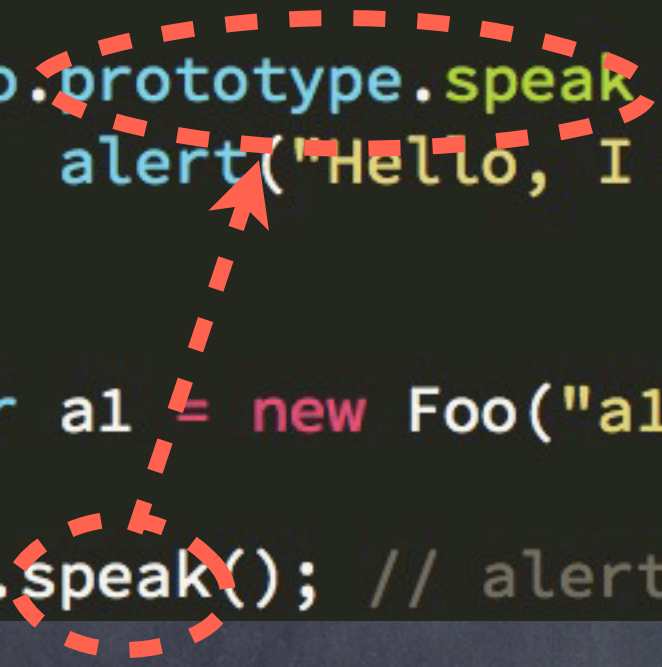


(another design pattern)

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."
```



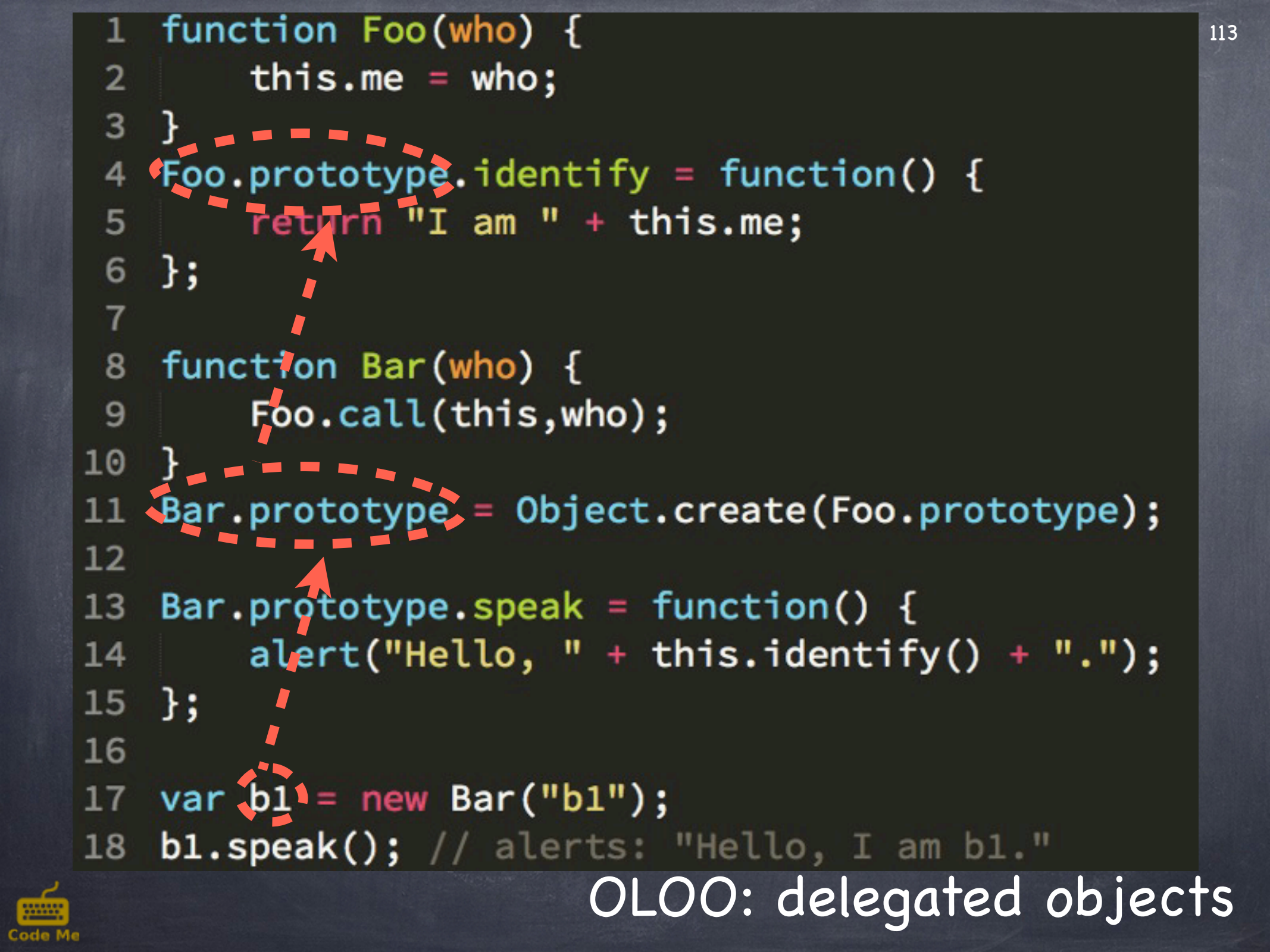
OO: ~~inheritance~~ delegation

Let's simplify!

OO: behavior delegation

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

```
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."
```

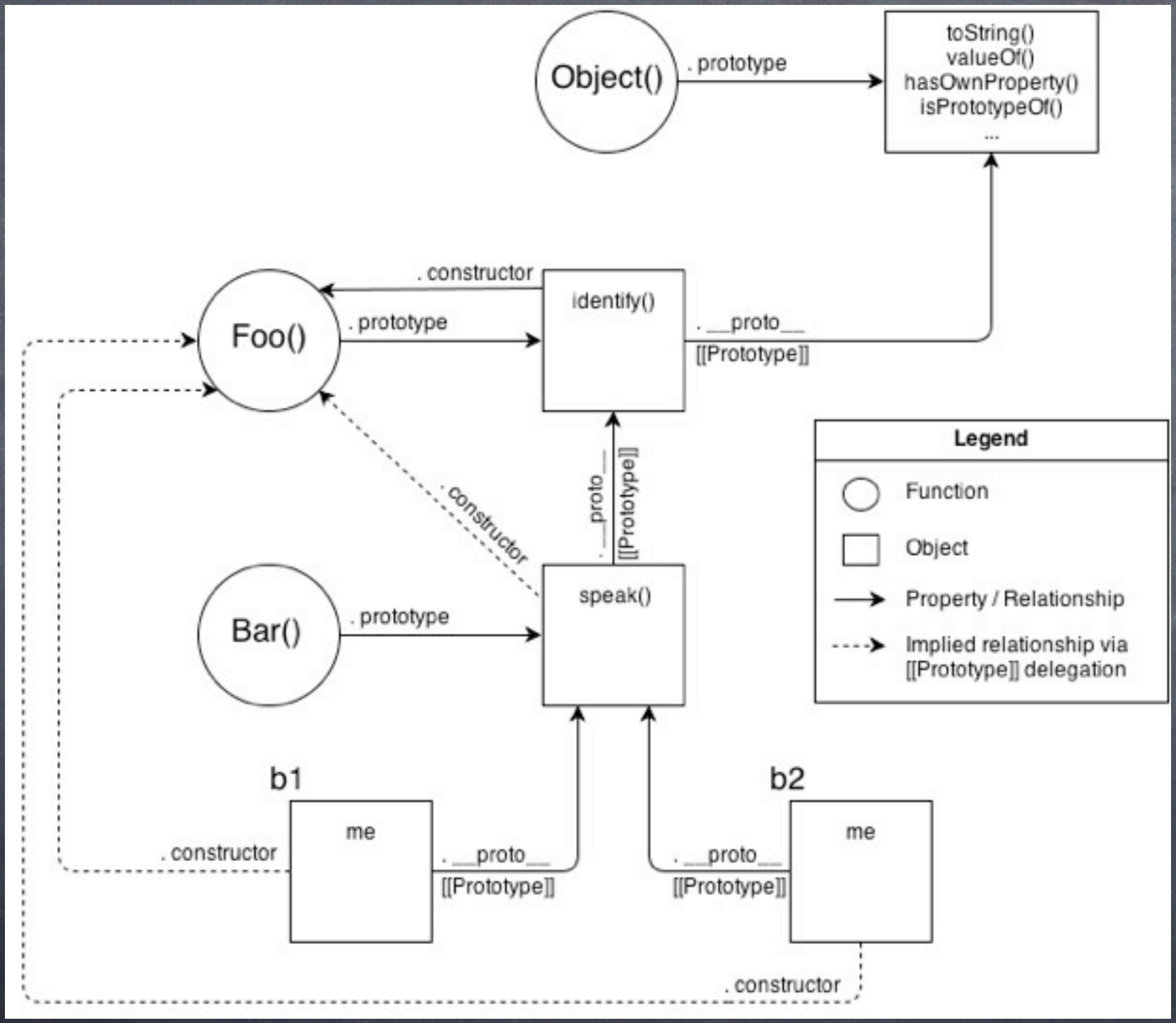
OLOO: delegated objects

```
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

```
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."
```

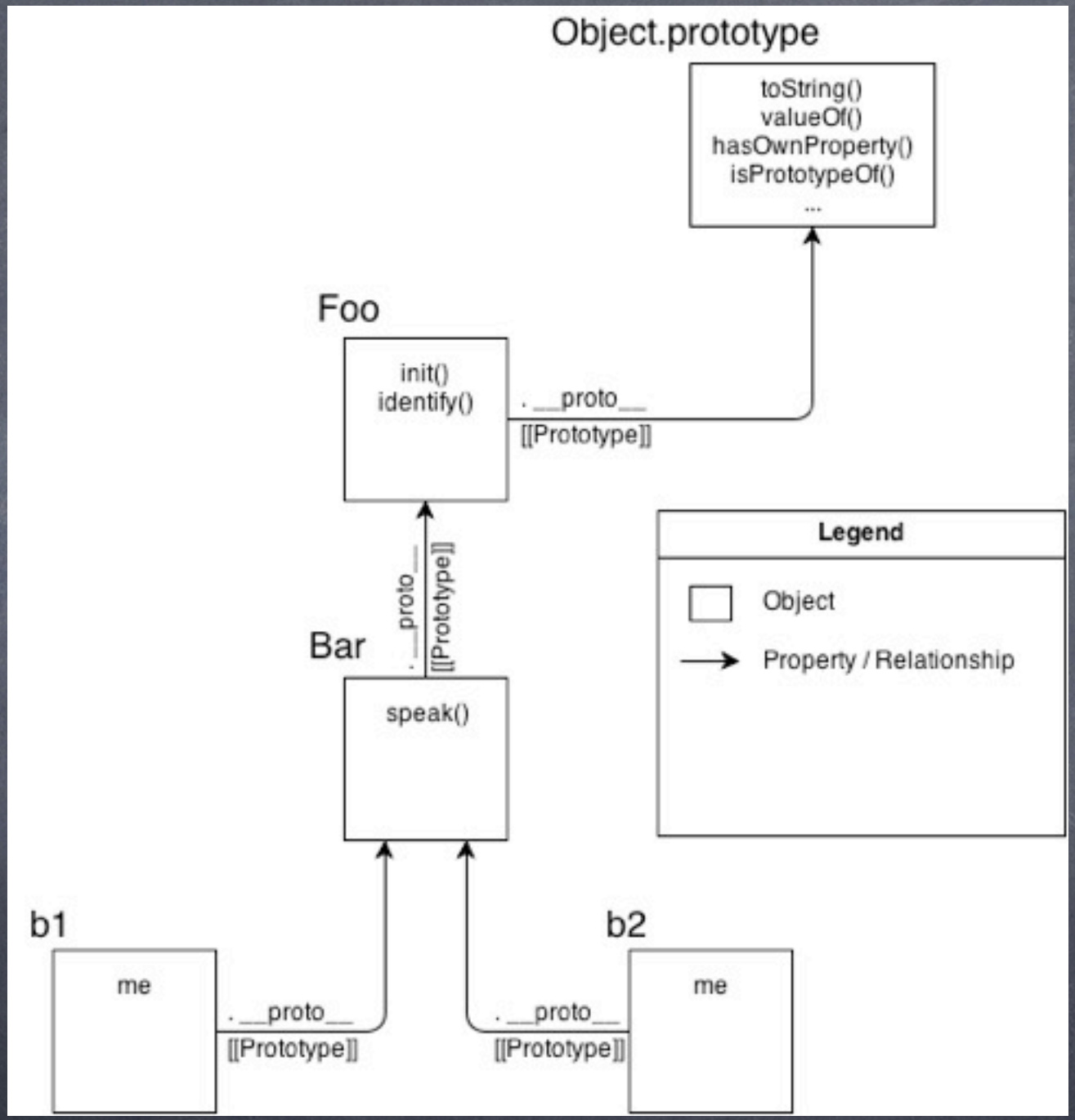
OO: old & busted



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

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 #4: 15min)

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

Async Patterns: "callback hell"

```
 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

Generators (yield)

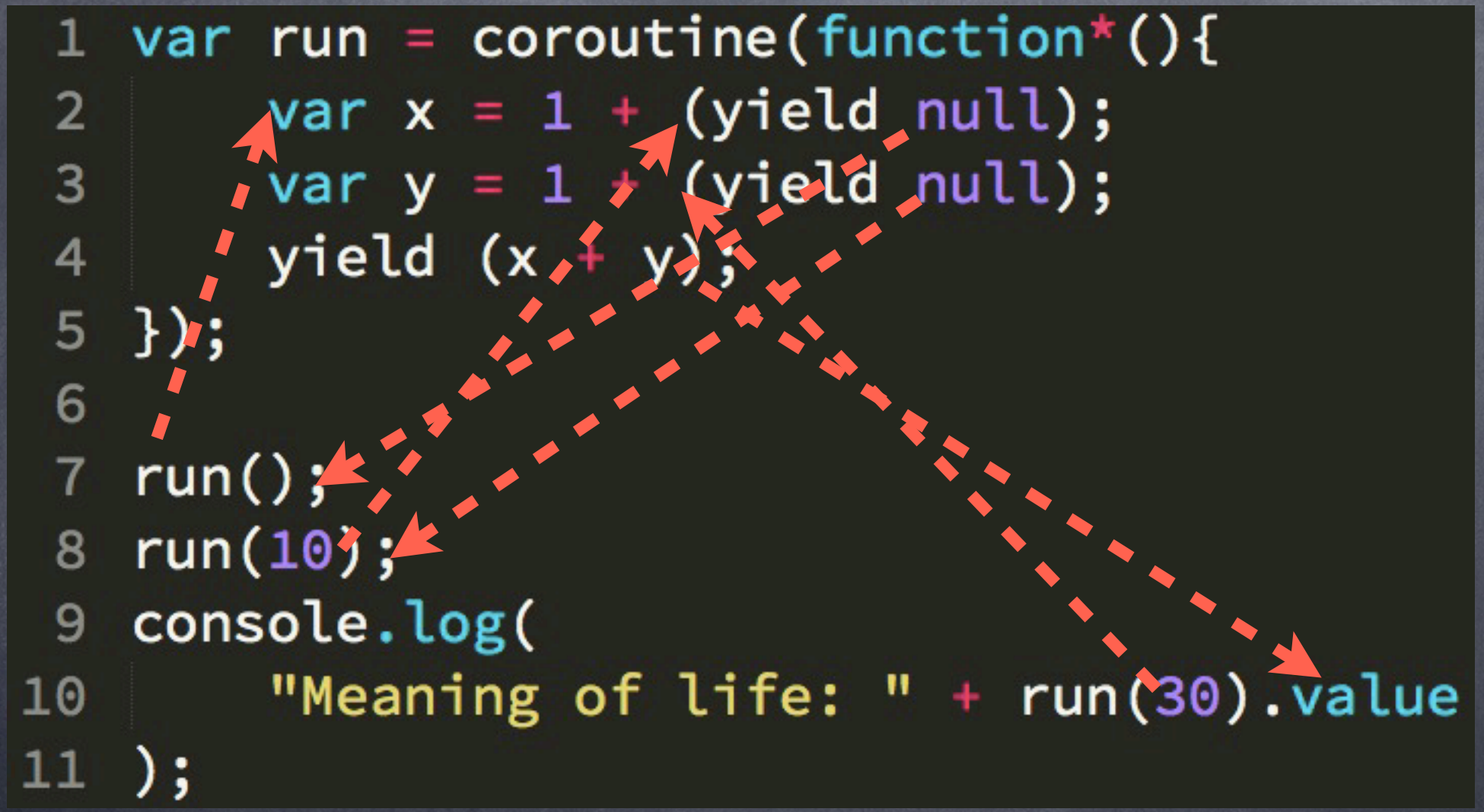
```
1 function* gen() {
2     console.log("Hello");
3     yield null;
4     console.log("World");
5 }
6
7 var it = gen();
8 it.next(); // prints "Hello"
9 it.next(); // prints "World"
```

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

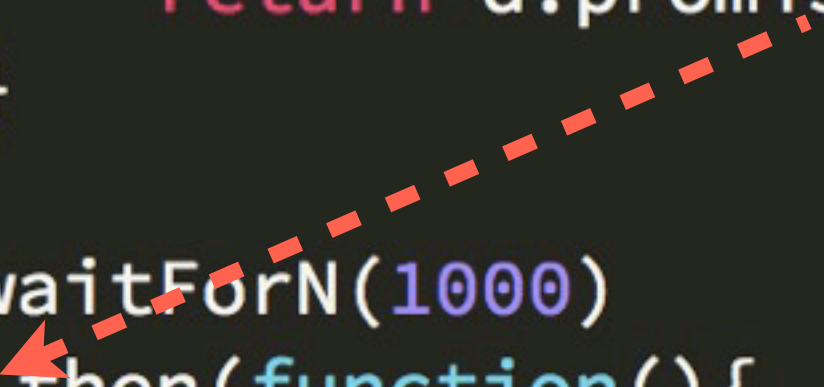
Promises

"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

```
function getData(d) {
    return new Promise(function(resolve,reject){
        setTimeout(function(){ resolve(d); },1000);
    });
}

var x;

getData(10)
.then(function(num1){
    x = 1 + num1;
    return getData(30);
})
.then(function(num2){
    var y = 1 + num2;
    return getData("Meaning of life: " + (x + y));
})
.then(function(answer){
    console.log(answer);
    // Meaning of life: 42
});
```

Async Patterns: (native) promise tasks

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

```
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

```
ASQ(2)
.runner(
    // v1 will be set as `2` here
    function*(v1) {
        console.log("initial v1:" + v1); // initial v1:2
        v1 += yield null;
        console.log("now v1:" + v1); // now v1:12
        v1 += yield getData(v1 * 2);
        console.log("finally v1:" + v1); // finally v1:84
        yield getData(v1 + 1);
    },
    function*() {
        var v2 = yield getData(10);
        console.log("initial v2:" + v2); // initial v2:24
        v2 += yield getData(v2 * 3);
        console.log("finally v2:" + v2); // finally v2:109
        yield getData(v2 + 6);
    }
)
.val(function(msg){
    console.log("Result: " + msg); // Result: 115
});
```

Async Patterns: CSP-style generators

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?

(exercise #5: 15min)

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Thanks!

Questions?